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"To the solid ground
Of nature trusts the Mind that builds for aye"—WORDSWORTH

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CENTRALIZED PLANNING AND THE HUMAN FACTOR

THE lectures on "Central Planning and Control in War and Peace", which were delivered by Sir Oliver Franks at the London School of Economics and Political Science during February and March and have since been published*, are a notable contribution to the discussion of forms of government required to serve our post-war needs. The outcome of the war-time experience of a philosopher who proved himself a successful administrator in the Ministry of Supply, they bear closely on the issues involved in numerous questions of current debate. Sir Oliver indeed limits himself to one topic, which he chose because of its fundamental importance in relation to the general pattern of economic activities in Britain during the coming decade; but much of what he has written is as relevant to discussions in other fields, such as the use of the scientific resources of Britain, and the numerous issues in town and country planning which have led to recent controversies.

The whole question of central planning and control is in fact controversial, and Sir Oliver recognizes that the application of central planning and control in peace must alter traditional conceptions and methods so extensively as to change the whole framework of economic activity. Central planning and control in peace are likely to be just as disturbing to the thoughts and habits of Governments dealing with business as to business itself. Whether such planning and control of the economic life of Britain is inevitable in the next decade is far too serious a question to be settled without deliberate and reflective discussion.

Sir Oliver draws on his war-time experience for his contribution to the discussion, and his reflexions lead him to conclude that some form of central planning and control is inevitable, and that the issue is not one which may be decided one way or the other according to the general political views of the party from which the Government is formed. This does not mean that the vast fabric of control organisations created during the War has to be re-created in peace, or that control in detail over so wide a field will be necessary. It is a question, too, which affects equally both private and public enterprise; but does not raise any issue between them or advocate a doctrine of nationalization. But it does mean that, so far as matters of principle are concerned, the subject should be withdrawn from political controversy.

This conclusion is based on consideration of military security, of the fear of unemployment and of the general condition of the world, all of which, conjoined with the special relation in which foreign trade stands to the British economy, suggest that no Government in the foreseeable future is likely to dare to do without export programmes and import programmes centrally planned and controlled. That is the position reached in the first lecture; but there is much more in the lecture. In his survey of the activities of the raw materials organisation of the Government to illustrate the way central planning and control worked in a particular field, Sir Oliver makes clear some most important points.

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* Central Planning in War and Peace: Three Lectures delivered at the London School of Economics and Political Science on the invitation of the Senate of the University of London. By Sir Oliver Franks. Pp. 61. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 2*s.* 6*d.*

This type of central planning only works if those who are involved in the decision feel bound by it and are convinced by rational considerations that what is proposed is as fair and reasonable as can be in the circumstances. A general plan or allocation is a practical directive for ensuing action, and it is necessary that the principal agents should acknowledge a commitment to the decision. Again, after planning comes the problem of control. Here the first function is verification of fact, and the second to ensure enactment; and what Sir Oliver brings out is the flexible character of the organisation built up for such purposes during the War.

Now if Sir Oliver is right in his conclusion that some form of central planning and control must in future characterize British economy, much that is done in the transitional years could be a constructive preparation for the longer years of peace. The essence of planning and control by the State in relation to productive industry and commercial activity is the same in war and in peace: decisions of policy quantitatively expressed in the form of programmes and such measures as in particular circumstances are necessary to ensure the performance of these programmes. Such planning and control, in fact, are normal characteristics of all practical activity that is in any way reflective, and in the field discussed by Sir Oliver the decisions which the State takes on its own responsibility and initiative are industrial and commercial decisions, and diminish the field in which business can display the same qualities by providing a framework of policies within which other similar but less general decisions must be made.

It is for this reason that what Sir Oliver has to say in his second lecture on the weaknesses of really large-scale organisation is important. Such weaknesses could scarcely have been explained better; the Civil Service has no monopoly of bureaucracy. The dangers of woolliness and inflexibility and inertia are admirably set forth, and special stress is laid upon the importance of effective communication and of foresight. Here again Sir Oliver draws on our war-time experience to find some clues to the principles upon which central planning and control could be organised in peace to have a reasonable prospect of success in the economic field.

The first and essential problem is that of purpose; and the main difficulty in central planning in peace is that of finding a common purpose understood and accepted by the nation and compelling support as the common objective. That involves much intelligent work in what may be described as the field of public relations; but it also involves much on the Government side that at present appears to be commonly disregarded. Central planning means, for example, that it is no longer possible for a Government to have a number of policies each of which can be pursued independently of the others. Housing, social security, exports, education, and defence are all factors in the general plan; the extent to which resources can be devoted to each is determined when the general balance is struck. It is also the Government's responsibility to create the necessary unity of purpose by the deliberate application of human intelligence and will.

There are other implications. Adoption of central planning and control in peace commits the Government to selecting and defining the ends of the national economy as an essential part of its planning and controlling activities. It engages the Government to a radical re-definition of its function in the economic field and to the shaping of situations before they arise. All this demands a real revolution in traditional habits of thought and makes a heavy call on leadership; and Sir Oliver makes it clear that reasonable success depends on the diffusion of initiative throughout the organisation and not on the Government side only. The Government, it is true, must take the general decisions involved in the programmes, but these should be kept as few as possible.

If initiative is to be diffused, clear and understood division of function is also essential. There must be no doubt where Government leaves off and business begins, and allocation of responsibility must follow. Exercise of initiative requires not only a job to do but also knowledge of responsibility for it. Responsibility for different functions must be placed, without equivocation and without strings, on those who perform them; and not the least valuable part of this admirable lecture is the way in which Sir Oliver drives home the implications. Beyond doubt he points the way to the establishment of that mutual confidence and understanding between industry and business and Government, whether Ministers or Civil servants, which are at the very root of effective planning and control.

The stress which Sir Oliver lays here on precision of thought and definition of responsibility, if the inherent woolliness of bureaucracy is to be overcome and the temptation resisted to avoid mistakes rather than to seize opportunities, makes a pertinent comment on current affairs. No less important, however, are his observations on what is involved in this method of agreement, which as he truly says is that of democratic procedure, reconciling equality of status with difference of function. It means that the Government must refrain from treating industry and commerce as instruments of its policy, and regard them instead as equal partners in the national enterprise with different but complementary functions. Agreement, moreover, is only possible when each party understands the mind of the other and full explanations are given of what is proposed, and there is free discussion on the basis of full information.

It would be idle to pretend that there at present exists either the full confidence in which such discussion and partnership can be fruitful or the balance of policies on the Government side which is essential to central planning. In his concluding lecture, however, Sir Oliver discusses the practical possibilities of achieving such a solution as he suggests, and the advantages which Great Britain has derived from its war-time experience and which, if used intelligently, could ease the transition. Chief among these he puts the more extensive and detailed knowledge of industry and commerce which the Government now possesses, the contacts between the Civil Service and industrialists, the experience which Government departments have gained in the methods and techniques needed for central planning. Moreover, many of the younger men who have returned to business life with a knowledge of the Civil Service from inside are now missing the satisfaction of doing a job which is related in a direct and intelligible way to the national need.

This question of incentive is more important than is yet generally realized, and Sir Oliver Franks is profoundly right in suggesting that for the future of Britain it would be a good thing to add to the dignity of work. He writes pertinently also on that vital factor, the co-ordination of Ministerial action, and leans to the idea of a Minister without departmental responsibilities as chairman of a committee of the Ministries concerned. Equally his own experience lends weight to Sir Oliver's comments on the functions of Civil servants in central planning, and his suggestions that it should be a first concern of the Civil Service to increase the number of experts at its disposal who are qualified both by training and knowledge of the world for the forecasting and estimating on which programmes must be framed and decisions based, and his reminder that right decisions and sound judgment depend on a fresh mind with some degree of leisure, are timely. The tendency to overload both Ministers and departments is probably the most serious consequence of the present tempo of the Government's programme, and may well be one of the hindrances to securing much freer and more spontaneous interdepartmental co-operation.

Sir Oliver is sceptical as to the value of an economic general staff, and suggests rather that the Government should encourage the formation of groups of industrialists and businessmen, strengthened by the inclusion of an academic economist and a trade union leader, with a Civil servant as chairman and terms of reference supplied by the Government. Such groups could do something to lessen the burden which planning imposes on the Civil Service, and the appointment of special assistants relieved of administrative departmental duties and free to think and plan might also lighten the burden of permanent secretaries and their deputies, if such assistants can work effectively with the main organisation.

These suggestions admittedly only touch the fringe of the difficulty, but to lighten the strain on senior Civil servants is one of the most urgent problems if central planning is adopted; and it is not the less imperative because of the responsibility which will also rest on the Civil Service for bringing industry and commerce effectively into the formation as well as the execution of plans. It is true that a new outlook on the part of industry and commerce will be required, and no matter how clearly the problem of communication is handled from the Government side a large responsibility must fall on the trade associations. Such bodies must be prepared to forward the initiative of their members within the general plans of the Government, and they must be much more concerned with the calibre of their representatives.

Nothing in these lectures encourages facile optimism as to the elaboration of the necessary organisation for planning. The stress is indeed on the human aspect and the time factor which must be allowed if we are to arrive at the sense of the meeting and collaboration which lies at the root of the democratic method.

These organic and human aspects of government are, indeed, the critical factors in any system which is to preserve the essential freedoms and the great intellectual and cultural traditions of civilization in any sphere of life, and not the less so in that the agenda of government is increasingly concerned with scientific and technical matters. Sir Oliver makes it abundantly clear that scientific method has much to contribute to the task of government, although he does not bring out so clearly as Sir Ernest Barker has done how much the method of democracy has in common with the procedure of science itself. The controversies over the Bankside Power Station and military training areas, or the development of a university policy or the most effective utilization of the nation's scientific resources in materials or man-power must indeed be resolved in part at least on a basis of fact, for the determination of which the method of science is required. But they also demand consideration of the human and social factors, if there is to be laid bare the common interest which will call forth the loyalty and the voluntary co-operation on which democratic planning depends for its success.

Sir Oliver Franks does not take us very far in his discussion as to how this is to be achieved. Prof. K. C. Wheare recently reminded us of the potential value of advisory bodies, and Sir Oliver's proposal for the formation of groups recalls some of the proposals for constitutional reform issued by a group of the Conservative Party last year. These proposals also included drawing on war-time experience to build up a system of sub-committees designed to secure the co-operation of able men from industry and trade and organised labour and to provide Government with something in the nature of an informal economic advisory staff, in addition to the existing Economic and Statistical Sections of the Cabinet Secretariat. Here, too, the emphasis is laid on quality rather than on the representation of interests, and the ultimate test of democratic planning will come just at this point of its capacity to develop the sense of the common interest which will secure the consent and co-operation of the Government.

That is brought out as soon as we examine in detail any problem of practical planning, whether in such diverse fields as the utilization of land, power and hydro-electric schemes or the expansion of the universities. There must indeed be some adequate and efficient administrative organisation, with resources and authority to execute the policy decided. But the means by which that policy is decided is the all-important factor in a democracy. It must include not merely the fact-finding facilities, but with them a technique and system of discussion which will assist in the formation of a public opinion and a general sense of common interest ensuring agreement and support for what is decided. In these lectures Sir Oliver Franks has set forth very faithfully some of the grave dangers inherent in any bureaucracy, no matter how great its merits. But while he reminds us of the importance of efficient organisation and respect for proved principles, he does not fail to point out that the man is more important than the machine. Whether our post-war organisation of Government proves equal to the immense tasks confronting it does not depend primarily upon the wisdom of our planning in the technical sense. It depends largely upon the men and women to whom the execution of those plans is entrusted. Nor is it simply a matter of their personal integrity, administrative ability and scientific and technical knowledge. It is a question of their physical ability to meet the strain. That, in turn, depends in part only on their numbers. Above all, success depends on whether in the preparation of plans and the formulation of policy the right steps have been taken to secure the approval and co-operation of the general body of citizens whose interests are to be served.

ECOLOGY OF NORWAY

Sikilsdalen og Norges fjellbeiter

En plantesosiologisk monografi. Av Rolf Nordhagen. (Bergens Museums, Skrifter Nr. 22.) Pp. xvi+607. (Bergen: A/s John Griegs Boktryckkeri, 1943.) 30 kr.

LOVERS of Norway, plant geographers, ecologists and systematists in many countries have cause for gratitude that Prof. Nordhagen's monumental study of Norwegian mountain vegetation in general and of Sikilsdal in particular was successfully published in 1943 in spite of enemy occupation of the country. The book is the culmination of twenty years indefatigable pioneer work, and the only cause for regret is that its weight and quarto size preclude its being carried in the pocket by a visitor. In every botanical library it should, however, find a place.

As explained by the author, the work is primarily a review of the ordinary mountain vegetation of Norway, exceptional areas, no matter how interesting, being on this occasion left aside. The vegetation is prevailingly that of non-calcareous or poorly calcareous districts with Sikilsdal as the fixed starting point. From the practical point of view it is the region of mountain pasture for horses, cattle or (formerly) reindeer, and the instruction of the potential user is constantly borne in mind in the presentation of the scientific descriptions. Indeed, some of the illuminating details intended for the guidance of the practical man are not the least interesting of the contents, the botanical criteria for the detection of late-lying snow pockets (of importance to a railway engineer) being a case in point.

Prof. Nordhagen's aim has been to reduce the bewildering details of his country's vegetational types into a manageable system of recognizable units, defined in such a way that comparison with other countries, notably Sweden, Finland and Central Europe, can be carried out, and by doing so to introduce into Norwegian science a standardized ecological language. This, and not the political vicissitudes prevailing at the time of publication, is the reason why the work is written in Norwegian rather than in some other language of perhaps wider currency; and quarrel with this decision cannot be made, for it will certainly strengthen considerably the further prosecution of ecological research in the author's own country. The non-Scandinavian reader need not, however, be unduly disturbed. The basic ecological classification was published in a preliminary form in German in 1936, and the book itself is very well supplied with indexes, table of contents, diagrams, tables and illustrations from which much information can be gleaned with little need of a dictionary.

The main climatic divisions utilized are first the separation of alpine from subalpine, the latter characterized by birch wood, and secondly, the subdivision of the treeless alpine zone into three regions, the low, middle and high alpine, the last being unrepresented in Sikilsdal. Within these zones the vegetational units are grouped under the following main heads, each containing several subdivisions: dwarf-shrub heath, dry grass heath, the vegetation of the sites of late-lying snow, tall herbaceous mountain vegetation, mountain meadow and grass pasture, nitrophilous weed vegetation near hutments, the vegetation of springs and of open water, grass moors, ericaceous moors, vegetation of unstable ground (screes, etc.), vegetation of precipices. In many cases, for example, in the masterly treatment of the complexities of grass moors, the classification is put forward as provisional, but even in such cases enough is known from the work of other writers to suggest that the units put forward have a validity and usefulness not merely for Norway but also for other northern countries.

It is impossible in a review to quote in any detail the scientific content of a work as richly filled as this. To a British botanist not the least of its value is the light that it can throw on many obscure features of the vegetation of our own islands. Peculiar and rare species, *Scheuchzeria palustris, Betula nana, Salix lanata, Phyllodoce cœrulea, Athyrium alpestre,* to quote a few at random, too uncommon with us to be adequately studied, fall into an intelligible place as relicts of a former age, in the light of Prof. Nordhagen's remarks. Indeed, it may be said with confidence that this description of Norway is likely to contribute more to an understanding of the general ecology of Scotland than has accrued from work done in that country for many years past.

I. MANTON

CRUDE DRUGS AND OTHER RAW MATERIALS OF VEGETABLE AND ANIMAL ORIGIN

Textbook of Pharmacognosy

By Dr. T. E. Wallis. Pp. ix + 504. (London: J. and A. Churchill, Ltd., 1946.) 28*s*.

ONE would naturally expect a high standard of attainment from the specialists who are responsible for the teaching of pharmaceutical subjects in the College of the Pharmaceutical Society of Great Britain. By virtue of its connexion with a body in which is vested the authority to grant diplomas for the practice of the craft of the pharmacist, it is right that the College should give a lead to those institutions concerned with instructing men and women for this profession. It is pleasing to see, therefore, that Dr. T. E. Wallis has produced a volume which maintains this tradition as regards pharmacognosy, following as he does the example of the late Prof. H. G. Greenish.

It is interesting to trace the development of this subject, during the past five decades, under these two men, both of whom have had a large share in establishing pharmacognosy in Great Britain on firm foundations as an important applied science. Dr. Wallis's influence is particularly seen in the appropriate monographs on drugs in the British Pharmacopœia and the British Pharmaceutical Codex. Greenish first published his "Introduction to the Study of Materia Medica" in 1899. The sixth and last edition, entitled "A Text-Book in Pharmacognosy", appeared in 1933 and embodied the changes in the revised British Pharmacopœia of 1932. This was the standard text-book in Great Britain over this period. Meanwhile Dr. Wallis, who had become more directly responsible for the teaching of pharmacognosy at "The Square", published a "Practical Pharmacognosy" in 1925. The fourth and last edition was published in 1943. First under Greenish, then independently, Wallis has exerted considerable influence on the concept of pharmacognosy, whether for the requirements of the Pharmaceutical Society's qualifying examinations or for the training of students in this subject.

Synchronizing as it does with his retirement from active teaching, we may assume that Dr. Wallis's text-book represents his mature views on pharmacognosy. Its scope is great and varied, and yet the ground is covered with that meticulous care for correctness of detail so characteristic of the man. His wide range of knowledge of plant and animal organisms and their products is most impressive. Every aspect of the subject is thoroughly explored and presented with a wealth of illustration which makes the subject-matter both interesting and instructive. Recent research and present trends in research are included. Contributions to research by Dr. Wallis and his school have been largely in the field of quantitative microscopy, in the devising and extending of methods for estimating amounts of admixture and sophistication in powdered drugs, so as to ensure conformity to legal requirements.

Dr. Wallis's classification of the subject-matter is based upon some fundamental characteristics which bring drugs into large groups each having some particular feature in common. Morphologically similar plant organs or tissues are grouped together, such as woods, barks and galls, leaves, flowers, etc. Plant products, extracts, etc., are grouped according to their nature into gums and saccharine substances; resins, gum-resins and oleo-resins; fixed oils, fats and waxes; and so forth. For teacher and student this arrangement has distinct advantages. Discussions of general principles are deferred to the end of the book. It is doubtful if all teachers of pharmacognosy will agree with the order of arrangement of the material. It must be remembered that many students entering a course in pharmacognosy have only had training of the standard laid down by the syllabus for the Pharmaceutical Society's Intermediate Examination. The reviewer feels, therefore, that to introduce the detailed histology of woods and barks near the beginning of the book is to expect rather much from such students.

Several minor corrections will need to be made when the text-book is revised. For example, it will be noted that a number of specific names starting with capital letters in the text have small letters in the captions to figures and in the index. Thus, Figs. 124 and 125 and also the index have *Datura stramonium*, the text *D. Stramonium*. The reviewer ventures to suggest that the author also includes available stomatal index numbers along with his other criteria in his descriptions of the respective drugs.

The text-book supplies much valuable information and carries with it the authority of a careful investigator and an experienced teacher. It is to be strongly recommended to teachers, students and all who are interested, directly or indirectly. His many friends hope that Dr. Wallis, in his retirement, will long be spared to maintain his vital interest in a subject he has made peculiarly his own, and will continue to give guidance and counsel to those who may be called upon to shape its further development and progress.

The publishers are to be congratulated on a work of high merit, even though still limited by Government austerity regulations. It would have been an advantage, however, if the text-book and Wallis's companion volume, "Practical Pharmacognosy", could have been made to conform in size.

W. O. HOWARTH

FUEL PRACTICE

Fuels, Combustion and Furnaces

By Prof. John Griswold. (McGraw-Hill Chemical Engineering Series.) Pp. vii+496. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 27*s*. 6*d*.

THE reader of this book can scarcely fail to notice how technical literature has developed during the past generation. Books used by students formerly were mainly descriptive. This applied to fuel technology—a subject amenable in part to considerable quantitative physical treatment. It includes industrial operations involving chemical reactions on the largest scale and of the greatest intensity. Indeed, some of these were used by the early pioneers in their studies of thermodynamic principles. It is not surprising that in time writers found it necessary, in the interpretation of technical processes, to use modern physical chemistry. In the United States, Haslam and Russell in 1926 produced their book on "Fuels and Their Combustion", which gave to many students the first approach of this kind. Since then developments in practice have taken place, and more particularly in petroleum technology. This deals in the main with liquid materials. These lend themselves especially to physical treatment, which is reflected by several chapters in this book by Griswold. While giving an account of fuel practice, at any rate of American practice, it is sprinkled throughout with references to modern physicochemical theory. This should be advantageous to many students who find difficult the same approach by way of text-books of abstract theory. There are many who would find the grasp easier when theory is associated with industrial processes.

In conclusion, one can say that the author has realized the aim of his preface, "to satisfy the need for an up-to-date chemical engineering text in this important field. It is the first attempt since that of Haslam and Russell twenty years ago to bring together an essentially fundamental background with developments in both theory and practice."

H. J. HODSMAN

THE CHEMICAL SOCIETY

By Dr. F. SHERWOOD TAYLOR

During July 15–17 of this year the Chemical Society is celebrating its centenary, which but for the War would have taken place in 1941.

The early scientific societies extended their activities to all branches of science; it was only at the beginning of the nineteenth century that societies for the study of special branches of science began to be formed. The Astronomical, Linnean and Geological Societies belong to this period. The Chemical Society was the first national body to take chemistry as its sole object of study, for it was not until 1857 that the French Chemical Society was formed, while the Berlin Chemical Society did not originate until 1868.

In the early nineteenth century there was a considerable body of Englishmen eminent in chemistry—the names of Dalton, Davy, Wollaston, Faraday come to mind. In the eighteen-forties, however, the main activity in the science was on the Continent, where Liebig, Wöhler, Bunsen, Dumas, Gerhardt and Berzelius were at the height of their powers. The British chemists of the time were well aware of the importance of the subject, both for pure science and for industry, and the first attempts to form a society met with a warm response. The moving spirit was Robert Warington, who on February 23, 1841, convened a meeting "for the purpose of taking into consideration the formation of a Chemical Society", which was duly constituted on March 30. Thomas Graham became president; Brande, Daniell, Clark, Daubeny and Grove were among the officers. The purposes of the Society were stated in the following words: "for the advancement of Chemistry and those branches of science immediately connected with it, for the communication and discussion of discoveries and observations relating to such subjects: the formation of a Library of scientific works and of a Museum of Chemical preparations and Standard Instruments are also ulterior objects of the Society". All these intentions, excepting the last, towards which only a beginning was made, have been carried out in a manner that its founders can scarcely have anticipated.

The Society began work at once and published from time to time *Memoirs* and *Reports of the Proceedings*. Membership increased, and in 1849 a Royal Charter was obtained.

The first meetings were held in the premises of the Society of Arts; in the same year they were removed to the Westminster Literary and Scientific Institution at 47 Leicester Square; but in 1843 returned to the Society of Arts. In 1850 the Society moved to 142 Strand, then to Cavendish Square, where it occupied a part of the premises of the Polytechnic Institution. About 1853 the Government promoted a plan for accommodating the scientific societies at Kensington Gore, but this found little favour. The Burlington House site was proposed instead, but it was not until 1874 that the new buildings were ready and the Society entered upon the premises it has now occupied for nearly three-quarters of a century. In that year its fellows numbered 733; to-day they number more than seven thousand, and in view of the parallel expansion of numbers both of men and books it is not surprising that further expansion has been in question.

The "communication and discussion of discoveries", set out as the Society's first intention, has been carried out by the reading and discussion of papers, and their publication. It is impossible to estimate the value of the thousands of discussions that have taken place at its meetings, opportunities for the sharing of ideas or the no less valuable clash of opinion, which has so often had the result of leading the research worker to re-examine his conclusions, clarify his explanations and reinforce his experimental proofs. We know that much of the work that led to the adoption of the correct views concerning atomic and molecular weights was done at these meetings, and in some instances by men, such as Odling, whose published work was comparatively unimpressive. These meetings have been of especial value to junior research workers, who find in them at once a means of contact with senior workers of reputation and experience and a strong encouragement in an often ill-rewarded pursuit.

The editors of the *Journal* have likewise done much to maintain the high standard of experimental proof for which the chemists of Britain are justly esteemed. The printing of scientific papers was among the first of the Society's activities. A volume of *Proceedings* and another of *Memoirs* appeared during 1841–43; these were followed by two volumes of *Memoirs and Proceedings of the Chemical Society of London*, and between 1847 and 1864 by fourteen volumes of the *Quarterly Journal*, which contained not only original papers, but also abstracts and official reports. During 1862–71 a *Monthly Journal* was published. Space was always a difficulty, and during this period abstracts were no longer published, but in 1871 "Abstracts of Chemical Papers published in British and Foreign Journals" were included in the *Journal*. From 1878 onward the *Transactions* and *Abstracts* were separated, while from the year 1885 the *Proceedings*, which had previously been scattered through the *Journal*, were separated and form a record of the Society's business and activities. After 1914 these were published in an abbreviated form with the *Journal* and no longer contained summaries of papers. In 1924 the publication of abstracts became the province of the Bureau of Abstracts and ceased to be part of the *Journal*. Finally, in 1933 the *Journal* adopted that larger format which is familiar to-day. A most valued publication of the Society is the *Annual Reports on the Progress of Chemistry*, first published in 1905; and in the present year a new publication has commenced, namely, *Quarterly Reviews*.

Next to the reception of the publications of the Chemical Society, the most valued privilege of its fellows is the use of the library. In 1842 the secretary was empowered to obtain a bookcase. The Society received many periodicals in exchange for its own, but in 1850 the library consisted only of some 330 volumes and a hundred pamphlets. In 1855 the president, Dr. Williamson, directed the attention of fellows to the library "as a place of deposit for curious works upon chemistry". In 1860 Mr. Watts took charge of the library, and a Library Committee was first appointed in 1866. He was succeeded by Dr. L. T. Thorne in 1884, who was followed in 1894 by Mr. R. Steele. In 1903 Mr. F. W. Clifford, assistant librarian at University College, was appointed librarian, and held that office until his death in 1942. His kindly and efficient aid and his store of remarkable anecdotes will long be remembered by the present generation of British chemists. He was succeeded by Mr. A. E. Cummins, who had been assistant librarian since 1919.

By 1890 the library, exclusive of pamphlets, amounted to 9,884 volumes; during Mr. Clifford's tenure of office, it greatly expanded and became the finest chemical library in the world. The number of books to-day amounts to some 48,000, and their issue to fellows, which seems to have been customary from the first, is a most valuable service.

In 1853 it was decided to add "a little more life and general interest to the meetings by devoting up to five meetings a year to delivery of discourses on matters connected with the progress of Chemistry". A good many lectures were given, but only a small proportion of them were printed; however, as these lectures became fewer and at the same time more weighty, their publication became commoner. Five lectureships have since been founded, of which the oldest is the Faraday Lectureship, which is normally given every three years and originally had to be delivered by a 'foreigner or someone from a British Colony'. The first lecturer was Dumas; he was followed by Cannizzaro, Hofmann, Wurtz, Helmholtz and Mendeléeff. Since then, Rayleigh, Ostwald, Emil Fischer, Richards, Arrhenius, Millikan, Willstätter, Bohr, Debye, Rutherford and Langmuir have delivered the Faraday Lecture, and the eighteenth of these lectures is to be delivered on July 16 by Sir Robert Robinson on "The Development of Electrochemical Theories of the Course of Reactions of Carbon Compounds". Since 1918 four other lectureships have been founded, namely, the Hugo Müller, the Liversidge, the Pedler and the Tilden Lectureships.

The Society also gives a very practical and direct aid to research through its Research Fund, which expends an annual sum of about £7,000 in grants towards the expenses incurred by research workers.

The accomplishment of the Chemical Society is principally to be measured by the benefit that has accrued to its members' work from the amenities and facilities it has provided. We cannot estimate the intensity of this benefit, but we may form some notion of its extensiveness by considering the work that British chemists have done and are doing. A brief survey of such work must give a false impression, for it can offer no idea of the enormous volume of pieces of work, not always notable by themselves, but in the mass forming the solid structure of the science of chemistry. The principal impression that is given by a survey of British chemistry during the past century is the great increase in its volume and value after the year 1900. Not only was more work done, but also its importance relative to the work being done at the same time in other countries greatly increased. In the nineteenth century there were fine pieces of work, such as Graham's treatment of colloids, Roscoe's researches on vanadium and Perkin's syntheses of aromatic dyestuffs, but from the beginning of the twentieth century the contribution of British chemists rapidly increases. The remoter causes of this expansion are not altogether clear, but there was certainly a wave of opinion near the turn of the century which led to a more active encouragement of research at the universities of Britain, and especially at Oxford and Cambridge. Be this as it may, the facts are sufficiently impressive. Witness, for example, the discovery of the inert gases by Rayleigh, Ramsay and Travers, the elucidation of the phenomena of radioactivity by Rutherford and Soddy, the opening up of the great field of crystal chemistry by the Braggs, the epoch-making researches of Moseley. In the field of organic chemistry the electrochemical theory of the course of organic reactions is the fruit of British researches, especially those of Robinson, who has contributed so brilliantly to so many departments of organic chemistry. It would be invidious to single out one or two researches from the mass of brilliant organic work that to-day occupies the greater part of the *Journal of the Chemical Society*, but the work of present members of the Chemical Society upon the carbohydrates, the steroids, proteins, and other classes of organic compounds, is well enough known to all. The subject of chemical kinetics has been remarkably developed in Britain, in numerous centres, and is represented in the person of this year's president, Prof. C. N. Hinshelwood.

All this work has contributed to, and has been aided by, the great development of the British chemical industry, which, after a period of stagnation in the latter part of the nineteenth and early twentieth century, has been built up to a position second only to that of the United States. Never has British chemistry seen a more brilliant period than the present, and we may look forward with confidence to newer and greater conquests, both in our knowledge of things, and their utilization for the benefit of mankind.

TECHNIQUE OF X-RAY POWDER PHOTOGRAPHY[*]

By H. P. ROOKSBY

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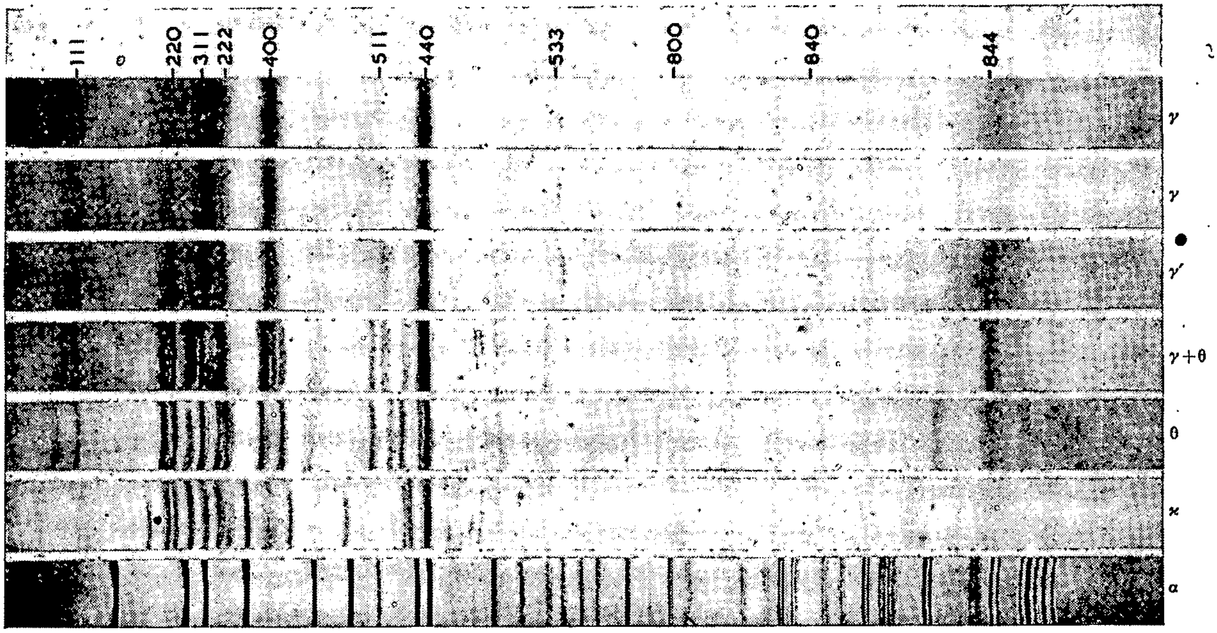
THE aspects of technique that influence the quality of the X-ray powder photograph can be classified into two groups: those concerned with the kind and purity of the X-radiation; and those concerned with the camera. A battery of X-ray tube target materials is desirable to give the necessary flexibility in the selection of wave-lengths. Demountable tubes in which targets are interchangeable, or sets in which sealed-off X-ray tubes containing different target elements can be quickly interchanged, provide alternative lines of approach.

In both schemes, some deterioration of the purity of the spectrum emitted by the tube has to be faced, though with the demountable set the provision of efficient evacuating equipment and regular cleaning of the target face minimize the difficulties. Nevertheless, it has to be recognized that a pure characteristic spectrum can only be maintained with certainty by the use of a crystal monochromator.

With Debye–Scherrer cameras mounted in the conventional position with respect to the X-ray tube target, line definition is primarily a function of specimen diameter and focal distance. There is a gain in resolution when the focal distance is lengthened by increasing the camera diameter. Cameras of maximum diameter of about 20 cm. have been adopted during the last few years; these are fitted with knife edges to provide reference shadows on the exposed negative. Accuracy of construction is essential to enable extrapolation methods to be applied for lattice parameter measurements[1]. Clarity of the powder photograph is improved by evacuation or hydrogen filling, and in some instances screening will help by the absorption of the secondary fluorescent radiation excited in the specimen.

[*] Abridgment of a lecture before the X-ray Analysis Group of the Institute of Physics delivered on April 22.



X-RAY POWDER PHOTOGRAPHS (COPPER *Kα* RADIATION, 19-CM. CAMERA) OF VARIOUS FORMS OF ANHYDROUS ALUMINA

A small flat crystal monochromator suitable for use with circular cameras has been described by Lipson, Riley and Nelson[2]. Bent crystal monochromators, such as have been advocated by Guinier[3] and others, have the advantage of utilizing the energy of the X-ray beam much more economically. They suffer from the disadvantages that special cameras are required, and that they are really unsuited for the line focus X-ray tube in common use in Great Britain. Increased sensitivity in analytical problems results from the use of crystal-reflected rays, because of the elimination of the white radiation component of the X-ray beam and consequent reduction of background.

One of the chief purposes for which the powdered-crystal photograph is employed in industrial applications is for the specification and identification of crystalline phases. Besides problems concerning phase diagrams in metallurgy, X-ray methods are applied to the exploration of new reacting systems in the fields of inorganic and organic chemistry. An interesting example is provided by the series of X-ray photographs distinguishing the principal phases in the alumina-water system. Not only are six or more separate constituents found, but also the transformation between the two anhydrous forms, gamma and alpha, is significant both crystallographically and practically (see accompanying illustration).

The X-ray study of iron oxides is another example, as differences in colour of iron oxide pigment preparations are known to be related primarily to changes in the crystal forms of the hydrated and anhydrous oxides[4]. The brown colour of gamma ferric oxide is markedly different from that of red hæmatite. Although the X-ray patterns of black magnetite and gamma ferric oxide are remarkably similar, that of gamma ferric oxide shows super-lattice lines as well as the displacements of the main lines associated with a smaller unit cell.

In the course of investigations of alumina/silica refractories, three forms of mullite have been distinguished by slight differences in their X-ray powder photographs[5]. The differences, which consist only of small relative displacements of high-order reflexions, are attributable to small changes in the unit cell dimensions. Some mullites of both natural and synthetic origin are found to contain up to 78 per cent of alumina compared with 72 per cent for the accepted composition with molecular formula $3Al_2O_3.2SiO_2$; yet the solid solution of the alumina effects but slight changes in the lattice parameters.

During the last few years, interest has been directed to structural anomalies or irregularities in certain substances. Powdered-crystal methods of investigation are applicable in many instances, provided the technique adopted gives sufficient clarity and resolution of the lines. In nickel oxide, for example, it has been shown that some reflexions are split into several components; there is a small distortion of the face-centred cubic structure, equivalent to a contraction along a [111] direction[6]. The nickel atom is slightly too small to allow the full cubic symmetry to be maintained.

Powder photographs of cobalt show exceptional effects, which are explained on the basis of mistakes in the stacking of the close-packed layers of cobalt ions[7]. Extra reflexions on X-ray photographs of graphite have been noted for some years[8]. They are real and not spurious lines attributable to the use of impure radiation, because they occur if the radiation is monochromatized by crystal reflexion. They cannot be accounted for by the hitherto accepted hexagonal structure, but are explained if it is assumed that in powdered graphites there is present a second closely related structure with one and a half times the cell height[9]. With most graphites, too, the X-ray powder lines show varying degrees of sharpness, attributable to imperfections in the stacking of the hexagonal nets of carbon atoms.

The significance of crystal structure in relation to physical properties such as refractive index, permittivity or piezo-electricity is becoming increasingly apparent. Polymorphic transformations with temperature such as those observed by Ubbelohde[10] and his colleagues in potassium dihydrogen phosphate and in barium titanate by Megaw[11] are examples. Although the work on potassium dihydrogen phosphate was carried out by single-crystal methods, studies of barium titanate and like compounds have been made by powdered-crystal technique. Such investigations require X-ray examinations at elevated and at sub-normal temperatures. There is obvious need for the provision of precision instruments for high- and low-temperature powder photography.

Concerning future prospects, emphasis must be placed on further developments and improvements in technique and instrumentation. Although the Geiger counter spectrometer may become extremely valuable, particularly in industrial research, the photographic film will no doubt continue to form the backbone of the powdered-crystal method for a long time to come. Much can be achieved by attention to detail and by the proper design of X-ray generators and cameras. Cameras, for example, should be such that they can be handled by any intelligent laboratory assistant, so that the X-ray crystallographer is free to devote his full energies to planning experiments and interpreting results. The work on the design of equipment being undertaken by the X-ray Analysis Group of the Institute of Physics should result in the early achievement of this ideal.

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HERMAPHRODITISM IN THE LOWER VERTEBRATES

By Dr. W. S. BULLOUGH*
University of Sheffield

BY the publication in 1944 of a description of the gonads of *Monopterus javanensis* Lac. (Symbranchii; Teleostei), Liu[1] has furnished new and interesting evidence concerning the mechanism of sex determination in the lower vertebrates, and has opened a fresh field for research into this subject. It is well known that, while the separate nature of the sexes is a general rule among fishes and amphibians, there are many species in which this separation is neither stable nor complete, and a great deal of research, both descriptive and experimental, has been devoted to the problem. In these circumstances it is exceptionally interesting to find that *Monopterus* is peculiar—and so far apparently unique—among vertebrates in being a true hermaphrodite, which functions as a female during the first half of its life and as a male during the second. It appears that this discovery may be one of considerable theoretical significance, and in order to place it into its proper context, the present state of our knowledge concerning sex determination in the lower vertebrates may be briefly summarized.

Vertebrate Sex Determination

The outlines of this problem were first defined by observation and description. It has become evident that while the primordial germ cells of the male and female are strictly homologous, those which are to form ova come to lie in the cortex of the rudimentary gonad, whereas those which are to form spermatozoa come to lie in the medulla. In many fishes and amphibians, the so-called 'undifferentiated races', it has been found normal for the cortical cells to develop first, with the result that all immature individuals pass through a female stage when their gonads contain oocytes. At this time genetical males cannot be distinguished from genetical females. The phenomenon has been particularly closely studied in amphibians, and has been reviewed in detail by Witschi[2,3]. Complementary to it is the observation, made on both fishes (Bullough[4]) and amphibians (Crew)[5], that older females commonly become transformed into males. It follows that in these species the basic difference between the sexes is not absolute, but lies merely in the duration of the female stage. In the male this stage is passed in immaturity, while in the female it lasts until almost the end of life. It is further evident that animals of this type occupy an intermediate position between a typical hermaphrodite and a typical gonochorist, and that they may illustrate an important evolutionary step.

Here a caution is probably needed that such normal sex reversals as those described above must be clearly distinguished from the many abnormal cases of intersexuality which have been reported in lower vertebrates (Bullough[6]), and which are presumably due to some individual maladjustment in the mechanism of sex determination or in the endocrine balance. Further, the peculiar condition of the Mediterranean teleosts *Serranus* and *Sargus*, in which ova and spermatozoa are ripened simultaneously (van Oordt[7]), is probably to be regarded as a unique specialization of the common mechanism.

The experimental work which has been performed on the problem of sex determination has been extensive and has so far produced the following main generalizations (Witschi[2,3]). The sex, or X-, chromosomes constitute the female-determining force called F, while the rest of the chromosome complex, the autosomes, are the male-determining force called M. In some invertebrates, such as *Bonellia*, the diploid condition might be designated by the letters $MMFF$, with the strength of M being approximately equal to that of F. In these circumstances the environmental conditions determine which sex shall be dominant. In the 'undifferentiated races' of amphibians, the sexes have come to be determined by the fact that one of the female chromosomes, the Y-chromosome, has a weaker effect than the other. Its reduced strength is termed f. In these circumstances a female has the constitution $MMFF$, where F is more powerful than M; whereas a male has the constitution $MMFf$, where $M + M$ is more powerful than F + the weaker f. However, the balance is still such that it can be upset by abnormal environmental conditions, as, for example, by a high temperature. Finally, in a typical gonochorist, the state is reached where the power of the Y-chromosome is nil. A female then has the constitution $MMFF$ and a male MMF, and in these circumstances sex is relatively stable from the earliest stage of development.

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* Sorby Research Fellow of the Royal Society.

The mode of action of these sex-determining forces is through a stimulation of inductor production within the indifferent gonad. The nature of the inductors is not yet understood, but they are known to diffuse from cell to cell and are presumed to be of a protein nature. The female inductor is called 'corticin', the male inductor is 'medullarin', and they are, of course, strongly antagonistic. It must be emphasized that they are not to be confused with the sex hormones of older animals. In the 'undifferentiated races' œstrogenic hormones can induce immature genetical males to develop into females just as androgenic hormones can induce immature genetical females to become males (Witschi[8]); but these effects would appear to be entirely artificial.

Research on the 'undifferentiated races' has also led to the further important conclusion that in these animals the chromosome balance between MM on one hand and FF or Ff on the other is not constant, but varies with age. This is the explanation of the fact that a male develops first as a female, since the influence of $F + f$ is felt before that of $M + M$. When the full power of $M + M$ is felt, the direction of development changes and the animal becomes transformed into a male. It is unfortunate that little or no experimental work has yet been done on the mechanism involved in the change of older females into males. It might be guessed that the nature of this change may be similar to that in young males, except that the sex hormones may play a significant part. Its basis may be that the relative power of $M + M$ finally rises to dominate that of $F + F$, either by an actual change in the powers of the chromosomes or by a change with age in the response of the gonads to them.

Hermaphroditism of *Monopterus*

The discovery of the condition of *Monopterus javanensis* makes the experimental study of adult sex changes even more urgently necessary, and because of the inaccessibility of the original paper, a restatement of the results already announced regarding this species may be of value. The fish itself is widespread in the rice fields of China, the Malay Archipelago, and the East Indies. It has an eel-like form, it is capable of breathing air, and it reaches a length of some 60 cm. Most of the 659 specimens on which the work is based were obtained from the market at various times throughout the year, and they were reported to have been caught in the rice fields of Pehpei and Hockwan in Swechwan, China. No secondary sexual characters can be identified in this species, and the sexes were therefore distinguished by the superficial appearance of the gonads. The intersexes were not at first recognized, and since they still possessed eggs they were classed as females. Consequently, with the accompanying table, the warning is given that the figures for females "possibly include a small number of intersexes". In this table, since age could not easily be determined, the state of the gonads is related to body-length.

The fish of the first three length-groups, referred to as fingerlings, were immature, but they were clearly recognizable as females. The next groups contained young adults which were also almost entirely female, and many of which contained fully developed eggs ready to be shed. The normal 1 : 1 sex ratio was found only in the narrow length-range of 36·0–37·9 cm. Of the 300 adult fish below this range, 270 (90 per cent) were females, while of the 210 fish above it, 185 (88 per cent) were males. It can only be concluded that all individuals commence life as females and breed as such before becoming transformed into males. In other words, "male and female in this fish are not distinct categories, but are merely temporary phases in the life of the same individual". For the greater part of the population the change in sex is accomplished between the body-lengths of 34 cm. and 40 cm., but occasional exceptions occur. Thus one specimen of only 23 cm. body-length was found to have completed a precocious change, while two others of 48 cm. and 50 cm. body-lengths respectively were still true females. These last two fish were obtained from a pond which was unusual in that it never dried up, and that it contained an abundant food supply. It is therefore suggested that such exceptions may be the result of abnormal living conditions, and particularly of abnormal nutrition.

FREQUENCY OF MALE AND FEMALE INDIVIDUALS IN DIFFERENT RANGES OF BODY-LENGTH

Class range in cm.	Male		Female		Total number
	Numbers	Percentage	Numbers	Percentage	
5·0–6·9	0	0	18	100·0	18
7·0–8·9	0	0	58	100·0	58
9·0–10·9	0	0	9	100·0	9
22·0–23·9	1	20·0	4	80·0	5
24·0–25·9	0	0	8	100·0	8
26·0–27·9	1	3·3	30	96·7	31
28·0–29·9	3	6·7	42	93·3	45
30·0–31·9	6	8·8	62	91·2	68
32·0–33·9	7	10·3	61	89·7	68
34·0–35·9	12	16·0	63	84·0	75
36·0–37·9	35	54·7	29	45·3	64
38·0–39·9	32	65·3	17	34·7	49
40·0–41·9	32	94·1	2	5·9	34
42·0–43·9	28	93·3	2	6·7	30
44·0–45·9	31	96·9	1	3·1	32
46·0–47·9	16	94·1	1	5·9	17
48·0–49·9	17	94·5	1	5·5	18
50·0–51·9	8	88·9	1	11·1	9
52·0–53·9	11	100·0	0	0	11
54·0–55·9	7	100·0	0	0	7
56·0–57·9	3	100·0	0	0	3

The histological details of the gonad transformation have not yet been closely studied by Liu; but the following short account can be given now. The ovary is bounded by a thick connective tissue tunica, from the dorsal side of which two long connective tissue folds hang into the ovary cavity. The cavity enclosed by each of these folds is empty, while the cavity between and around the two folds contains the oocytes. During the change of sex, testicular tissue arises within the walls of the connective tissue folds, and simultaneously the oocytes begin to disintegrate, the largest being affected first. By the time the testicular tissue is fully developed, the oocytes have entirely disappeared.

Conclusions

It will be evident that these observations on *Monopterus* agree well with those already made on the various 'undifferentiated races' of the lower vertebrates. In the first place, *Monopterus* shows the normal juvenile female phase, and in the second the sex-change is in the normal direction of female to male. Indeed, the only difference between it and the other fish and amphibians mentioned above is one of degree. In *Monopterus* all individuals change their sex at about the same age, while in the others half (the males) make the change early, and half (the females) make it late or not at all. However, this difference is of considerable theoretical interest, and it is important that an attempt should be made to discover whether the hermaphrodite condition of *Monopterus* is primitive or specialized.

The evidence available from the study of the various 'undifferentiated races' can be held to support a theory that some, if not all, of the members of the old vertebrate stock were protogynous hermaphrodites, and that only afterwards were separate sexes established by the evolution of a chromosome mechanism which caused a progressively earlier sex change in the forming males and a progressively later one in the forming females. Thus *Monopterus* may be to-day in a condition similar to that of the earliest vertebrates. Unfortunately for this theory, the primitive nature of any of the features of *Monopterus* cannot be lightly assumed. It belongs to an aberrant order, the Symbranchii, the affinities of which have not yet been fully settled, and it may well be that the mechanism of its sex reversal is as specialized as is its bodily structure. One test which might be applied is to search for some trace of a Y-chromosome. If the hermaphrodite condition is primitive, this chromosome may be lacking; but if it is secondary, it may still be distinguishable by its shape. It is clearly a matter of great interest that further and more detailed research should be carried out on this unusual fish, and also that a search for similar conditions should be made in the other members of the order Symbranchii.

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OBITUARIES

Sir Thomas Holland, K.C.S.I., K.C.I.E., F.R.S.

With the unexpected death of Sir Thomas Henry Holland, on May 15, British geology in general and Indian geology in particular has lost its most illustrious figure, one whose outstanding position was recognized by the fact that he was president designate of the Eighteenth Session of the International Geological Congress to be held in Great Britain in 1948, and was also president of the Organising Committee of this Congress.

Thomas Henry Holland was born on November 22, 1868, at Helston, Cornwall, and was the son of John Holland, of Springfield, Manitoba, Canada, and Grace Treloar Roberts.

He was educated at a small dame's school at Helston, and when only sixteen won a National Scholarship to the Royal College of Science, London, where he took a first class associateship in geology with honours, in 1888, winning also the Murchison Medal and Prize. After a period at South Kensington as assistant to Prof. Judd, he gained a Berkeley Fellowship to Owens College, Manchester, in 1889. In 1890, at the age of twenty-one, he was appointed an assistant superintendent in the Geological Survey of India. He did not, however, proceed direct to his appointment, but travelled to India via the United States, Canada and the Far East, his service dating from his arrival in Calcutta in October 1890, when he was made curator of the Geological Museum and Laboratory. In addition, he became the part-time lecturer in geology at Presidency College, Calcutta, where (there being then no professorship in geology) he organised the courses in geology and established securely the custom that prevailed for many years by which the curator of the Geological Survey of India usually also lectured at Presidency College. While curator, Holland effected many improvements in the arrangement of the Mineral Gallery of the Museum, continuing the work begun by F. R. Mallet. In particular, he assembled and arranged typical collections of the pre-Cambrian (including Archæan) formations of India.

Although, by holding the post of curator for some years, Holland was nominally stationed at headquarters in Calcutta, he made repeated excursions into the field, and was also available to the director of the Geological Survey for emergency inquiries as they arose. He thus soon established for himself a reputation as a petrographer, and as one interested in the economic side of geology; that he was a man of energy and organising ability the Government of India soon became aware.

Throughout its history, the Geological Survey had devoted a considerable part of its energies to the mapping and study of the Indian coalfields, and had also recently had a specialist (F. H. Hatch) at work on certain gold deposits. Yet on the whole the department was then, in the view of the Government of India, giving too much attention to the theoretical side of geology and too little to the practical side. The consequence was that in February 1903 Holland was appointed director in succession to C. L. Griesbach, who was retiring on superannuation. This meant the supersession of several geologists senior to Holland, some of them (for example, R. D. Oldham, C. S. Middlemiss and T. D. La Touche) of first-class quality. After the initial shock, however, they collaborated loyally with the young new director (Oldham retiring two years later), and Holland set to work to reorganise the work of the department and to raise its status, both with Government and with the business public. He secured from the Government of India an increase of staff and better terms of pay, and detailed some of his officers to make comprehensive studies, scientific and economic, of particular minerals (for example, coal, manganese ore, and petroleum) on the lines he had already set for mica before his promotion.

In addition, Holland secured the transfer from the Revenue and Agriculture Department of the Government of India to the Geological Survey the duty of collecting and collating the statistics of mineral production of India, in annual reviews published in the *Records of the Geological Survey of India*, which he resuscitated after their suppression by his predecessor. Further, he instituted the well-known quinquennial reviews of mineral production, the first one actually covering a six-year period, 1898–1903. These quinquennial reviews are not mere assemblages of the annual figures. They contain, also, geological and economic data, covering each mineral, that are not in the annual reviews; and they were, until 1933, a special feature of the *Records* of the Indian Geological Survey that had no parallel among the publications of any other geological survey in the world.

Holland also secured the transfer to the Geological Survey of the duty of advising the Central and Provincial Governments concerning the terms of the grant of mineral concessions throughout British India, the existing rules being still based on the rules as revised by him. He was also president (1908) of the Burma Oil Reserves Committee, which drew up the rules for the regulation of the Burma oilfields with the object of preventing their wasting competitive exploitation by rival companies.

In spite of the great number of administrative improvements effected by Holland, he was director of the Geological Survey only until 1909, when he accepted an invitation to the chair of geology of the University of Manchester. One of the reasons for his early retirement from India was his disappointment that the Government of India had not implemented in full his scheme for the increase of staff and scales of pay of his department. However, Holland's outstanding services to science in India were recognized by the award of the K.C.I.E. in 1908.

It is not too much to say that as a result of Holland's directorship the Geological Survey of India was permanently faulted up, to use a geological simile, into a position of prestige in India, both with Government and with the public, from which it has never fallen back. His successor, Sir Henry Hayden, for example, quite early secured the increased cadre and scales of pay for which Holland had fought.

Sir Thomas, as he had now become, was, however, destined to return to India; in 1916 he was appointed chairman of the Indian Industrial Commission, the report of which may be taken as a basis of the Government of India's help in the modern industrial development of India. The knowledge of Indian industries obtained during its investigations led to the whole Industrial Commission being converted, also in 1916, into the Indian Munitions Board, with Holland as president; and all who had the privilege of working under Holland in this Board know the skill and energy with which he built up the giant organisation that kept the Indian armies, wherever employed, supplied with all the varied munitions and stores required for modern warfare. It is fair to say that three men, the Commander-in-Chief, the Finance Member to the Government of India, and the President of the Board of Munitions, were the principal organisers and directors of India's military effort in the First World War. For his share in this Sir Thomas was created K.C.S.I. in 1918. When the War ended, the Indian Munitions Board became, in 1919, the Department of Munitions and Industries, Holland thus becoming a member of the Viceroy's Executive Council. In 1921 he was also appointed Member for Commerce, so that he held two portfolios simultaneously. At the end of 1921 a difference with the Viceroy (Lord Reading) on the withdrawal of a munitions prosecution in Calcutta led to Holland's resignation; but the sympathies of all who knew the inner facts were with Sir Thomas Holland.

This check in Holland's career was but of brief duration. In 1922 he succeeded Sir Alfred Keogh as rector of the Imperial College of Science and Technology, London; and his success as an educational administrator in this post led to his appointment in 1929 as principal and vice-chancellor of the University of Edinburgh in succession to Sir Alfred Ewing. In spite of his dictum that seven years in one appointment was sufficient, Sir Thomas held the Edinburgh office for fifteen years, retiring in 1944 at the age of seventy-six with the title of emeritus principal and vice-chancellor of the University.

It must also be recorded that after retiring from the Geological Survey of India, Sir Thomas retained his interest in oil problems. Thus, he was a member of the Royal Commission on Navy Fuel, 1911–13. In 1928 he visited Trinidad and reported to the Colonial Office on policy in promoting the maximum and most efficient exploitation of the Island's oil resources. He was for many years geological consultant to the Burmah Oil Company and for nearly twelve years a member of the geological advisory board of the Anglo-Iranian Oil Company.

Although Holland was thus almost continuously in harness for fifty-four years, his outstanding energy and organising ability led naturally to his taking also a prominent part in the administration of scientific and technical societies and institutions. He commenced by founding in 1906 (with the late W. H. Pickering, chief inspector of mines in India) the Mining and Geological Institute of India, of which he became the first president. He was chairman of the trustees of the Indian Museum, Calcutta, 1906–9, and in 1909 he was president of the Asiatic Society of Bengal (now the Royal Asiatic Society of Bengal). In 1915–16 he was president of the Institution of Mining Engineers, London. Later, he was president of the Institution of Mining and Metallurgy, and of the Institution of Petroleum Technologists, and chairman of the Royal Society of Arts, all at the same time (1925–27). During 1927–30 Holland was chairman of the Empire Congress of Mining and Metallurgical Institutions, and in 1933–34 he was president of the Geological Society of London and in 1933–36 of the Mineralogical Society. He also served the British Association as a sectional president (geology, 1914, and education, 1926) and was president of the Association at its meeting in South Africa in 1929. He was a vice-president of the Royal Society in 1924–25.

On his retirement from Edinburgh in 1944, Sir Thomas returned to London with vigour of mind and body unimpaired, and resumed his practical interest in the administration of learned and technical societies. He rejoined the Council of the Institution of Mining and Metallurgy as a past-president, and became foreign secretary to both the Geological Society and the Mineralogical Society, his seniority and personal friendship with many geologists and mineralogists abroad making him peculiarly suitable for such work. Further, as already mentioned, he was to be president of next year's International Geological Congress.

It was inevitable that a man of such outstanding ability and energy should be the recipient of many honours in addition to the awards of K.C.I.E. and K.C.S.I. already mentioned. In addition to honorary degrees from many universities he received the Bigsby Medal of the Geological Society of London (1913), the Albert Medal (1939) of the Royal Society of Arts, and was an honorary fellow of the Royal Asiatic Society of Bengal.

Although Holland, from the time of his promotion to the directorship of the Geological Survey of India at the very early age of thirty-four, devoted his energies and abilities mainly to scientific and educational administration, yet he had already to his credit a considerable volume of first-class research, mainly on the petrographical (and chemical) side of geology; this was recognized by his election to the Royal Society in 1904. His published papers include five *Memoirs*, of which one is on the charnockite series (1900), another deals with his discovery of elæolite-syenites in India (the Sivamalai series, 1901), and a third is a comprehensive work on the mica deposits of India (1902), dealing with both the scientific and economic aspects of a mineral of which

India is the world's chief source of supply. Many of his papers in the *Records of the Geological Survey of India* also deal with petrographical problems, of which the most noteworthy are perhaps those on the mica–apatite–peridotite intrusions in the Bengal coalfields (1894) and on the origin and growth of garnets (1896). Holland also recognized early the essential identity of bauxite and laterite (*Geol. Mag.*, 1903). One of Holland's earliest papers, that on the Gohna landslip, Garhwal (*Records, Geol. Sur. India*, 27; 1894), recorded work that created a sensation with the Indian public. A landslip had thrown a dam across a Himalayan valley and created a large lake where there had been none before. Holland, who was sent to investigate, gave a middle date for the breaching of the dam and the depth to which it would be cut down when this happened. He also recommended the evacuation of the population endangered by the prospective floods some time in advance of his date. This was done, and the dam was breached on almost the exact date predicted. Holland also gave valuable advice in connexion with landslips in the hill stations of Naini Tal and Darjeeling.

The research for which Holland is best known to science is that described in his *Memoir* (28, Pt. 2; 1900) on the charnockite series, in which he described a peculiar series of granulitic rocks ranging in composition from acid to ultrabasic and forming an important part of the Archæan terrain of the Madras Presidency. The common denominator in these rocks is the presence of hypersthene; and for the type rock, a hypersthene-granite, Holland selected the name 'charnockite' after Job Charnock, the founder of Calcutta. Charnock's tomb is in St. John's Churchyard, Calcutta, and, as Holland discovered, is fashioned out of a block of hypersthene-granite brought from Madras. In Holland's view, all the members of his charnockite series are consanguineous and form a petrographic province of genetically related plutonic igneous rocks. Similar rocks have been found since in other countries, for example, Antarctica, West Africa and Uganda, and their origin has for many years been a matter of controversy. Whatever may be the final verdict on the origin of this interesting suite, there can be no doubt as to the importance of Holland's work thereon, and of the stimulus it imparted in many countries to the study of their hypersthenic rocks, and in India to that of the Archæan terrain in general.

Whatever Holland wrote, whether in official correspondence, or for publication, was precise and clear, and often trenchant. His presidential addresses to learned and technical societies never went into details, but always dealt with broad outlines, so that they were of widespread interest. In his earliest such address (that to the Mining and Geological Institute of India in 1906) he proposed a new scheme for classifying the geological formations of India, holding that the main divisions suitable for Europe, where stratigraphical nomenclature originated, were not suitable for Gondwanaland with its very different geological history. Thus came to be introduced the terms 'Aryan', 'Dravidian' and 'Purana', with Archæan at the base, for the larger subdivisions of the geological column in India. This interest in stratigraphical nomenclature caused Sir Thomas after his first retirement from India to write his "Indian Geological Terminology" (*Mem., Geol. Sur. India*, 43, Pt. 1; 1913), in which he was helped by the late Mr. G. H. Tipper (see *Nature*, June 21, p. 834), and of which a second edition appeared in 1926.

In his first address as president of the Geological Society of London (1933), Sir Thomas discussed "The Geological Age of the Glacial Horizon at the Base of the Gondwana Systems", showing that this horizon is one of the most important datum lines of the geological column. In his second address (1934) he took as his theme the ideal composition and minimum strength of a geological survey department if it was to be fully efficient. This address has been, and is likely in the future to be, of great use to directors trying to convince their Governments of the needs of their departments. In his address as president of the Geological Section of the British Association in Australia in 1914, Sir Thomas reviewed recent advances in developing theoretical conceptions regarding the interior of the earth that are of direct importance to geologists. In his address as president of the Association at Johannesburg in 1929 he discussed "The International Relationship of Minerals". Sir Thomas was greatly interested in the impact of the economics of mineral deposits upon national and international affairs, as was shown by this and other addresses, and as was summarized in a small book entitled "The Mineral Sanction as an Aid to International Security" (Oliver and Boyd, 1935), in which he showed, before the recent War, that if the British Commonwealth, the United States of America and the U.S.S.R. were to adopt a common policy on the export of minerals of use for munitions purposes to potentially aggressor countries, such as Germany and Japan, the outbreak of war could be prevented.

As will be judged from the foregoing, Sir Thomas Holland was a man of outstanding ability and energy. His worship of efficiency meant that he could not suffer fools, and that in his official relations his reactions to his colleagues and subordinates were mainly determined by his desire for efficiency, with handsome recognition of good work. But in private life Holland could be a delightful companion, especially as he was a good *raconteur* with an endless fund of amusing stories.

Holland married first, in 1896, Frances Maud (who died in June 1942), daughter of the late Charles Chapman, Deputy Commissioner in Oudh, and by this marriage he had one son (now Major-General John F. C. Holland) and one daughter (Margaretta, widow of Col. A. G. Shea); and secondly, in 1946, Helen E. Verrall, of Bramley, near Guildford.

L. L. FERMOR

Prof. F. Pavlíček

PROF. FRANTIŠEK PAVLÍČEK, who died on January 4 at the age of seventy-two, was one of Brauner's earlier pupils. Brauner and Pavlíček undertook in 1900 the revision of the atomic weight of lanthanum, and their results were eventually published in the *Transactions of the Chemical Society* in a lengthy paper. The figure they obtained, 139·04, is still accepted. Most of Pavlíček's later work was connected with mineralogy, fuel technology and thermochemistry, since he held appointments first at a technical college in Brno and later at the Příbram School of Mines in South-West Bohemia. These investigations, mostly published in Czech, relate to the calorific values of various coals (including local lignites) and the utilization of coal gas, industrial gases and coke in metallurgy. Prof. Pavlíček also wrote, in 1927 and 1931, the standard Czech work on the chemistry of coal.

J. G. F. DRUCE

NEWS and VIEWS

Chemistry in London

The Chemical Society, the centenary of which fell in 1941, is celebrating the occasion during July 15–17 (see p. 6 of this issue) by a series of meetings in London. Whereas only two overseas countries, France and Germany, sent representatives to the jubilee meetings, some twenty different countries will be represented. Among the bodies represented will be the Australian Chemical Institute, the Chemical Institute of Canada, the New Zealand Institute of Chemistry and the South African Chemical Institute. The Irish Chemical Association is sending its president, Dr. Vincent Barry. India will be represented by a distinguished delegation including Sir Shanti Bhatnagar, Sir J. C. Ghosh and Dr. Venkataraman. Other Commonwealth local representatives who will be present are Dr. T. Iredale (Australia), Prof. W. D. McFarlane (Canada), Prof. W. Pugh (South Africa) and Prof. T. S. Wheeler (Eire).

France will be represented by Prof. R. Delaby, president, and Dr. G. Champetier, secretary, of the Société Chimique de France, and by a representative of the Société de Chimie Industrielle. The Société Chimique de Belgique will send Prof. J. Timmermans. Dr. H. Jørgensen will be the official representative of the Kemisk Forening, Copenhagen, and will be accompanied by Profs. Niels Bohr, N. Bjerrum and N. J. Brønsted. Profs. G. de Hevesy and H. Erdtman will represent the Royal Swedish Academy of Sciences and the Swedish Chemical Society. Prof. E. Berner, president of the Norwegian Chemical Society, will represent Norway. Prof. D. Marotta will represent the Societa Chimica Italiana. Prof. Paul Karrer will be the official representative of the Swiss Chemical Society, and he will be accompanied by Prof. L. Ruzicka. A very strong delegation will come from the great sister organisation, the largest chemical society in the world, namely, the American Chemical Society, the official delegates of which will be the president, Dr. W. A. Noyes, jun., president-elect, Dr. C. A. Thomas, and secretary, Mr. A. H. Emery. Other Americans present will be Colonel Marston T. Bogert and Prof. Linus Pauling. China will be represented by Prof. Edith Chu.

Following on the Chemical Society celebrations, there will be the eleventh International Congress of Pure and Applied Chemistry, which is being held chiefly at the Imperial College of Science and Technology, South Kensington, during July 17–24, and concurrently, meetings of the International Union of Chemistry in the apartments of the Royal Society. Lord Leverhulme is president of the Congress, which is meeting in fourteen sections, one of them being a new one formed at the request of France to discuss chemistry in relation to essential oils, flavouring materials and cosmetics. It is expected that some two thousand chemists from at least twenty-four different countries will attend. The opening ceremony by the president of the Congress and the closing session, consisting of a lecture by Sir Robert Robinson, president of the Royal Society, will be at the Central Hall, Westminster, and all other sessions at the Imperial College of Science and Technology, South Kensington. The last International Congress of Pure and Applied Chemistry, which normally is held every four years, was in Rome in 1938; the only previous one to be held in London was in 1909. The first was in Brussels in 1894.

Chemistry in Glasgow: Opening of the Henderson Laboratory

At a short ceremony held in the Chemistry Department of the University of Glasgow on the afternoon of June 25, Sir Robert Robinson named the new Henderson Laboratory. This Laboratory had been occupied by the Admiralty during the War; and the University's share in the cost of its re-equipment to provide up-to-date accommodation for sixteen graduate research workers in organic chemistry has been partly met from a fund raised in memory of Henderson's work both at the Royal Technical College (1892–1919) and at the University (1919–37). Prof. J. W. Cook paid tribute to Henderson on behalf of the University and Prof. W. M. Cumming on behalf of the Royal Technical College. Dr. J. W. McDavid (chairman of the Explosives Division of Imperial Chemical Industries) moved a vote of thanks to Sir Robert Robinson. Sir John Boyd Orr, the newly installed chancellor of the University, was present, as was also the principal, Sir Hector Hetherington. Earlier in the day the University had conferred upon Sir Robert Robinson the honorary degree of LL.D.

Zoology at Birmingham: Prof. P. B. Medawar

Mr. P. B. Medawar, fellow of Magdalen College, University demonstrator and lecturer in the Department of Zoology and Comparative Anatomy, Oxford, has been elected to the chair of zoology in the University of Birmingham. Not yet thirty-three, he has had a brilliant career at Oxford, winning a Christopher Welch Research Scholarship in 1935, the Edward Chapman Research Prize in 1938, and the Rolleston Memorial Prize in 1942. While his outlook is physiological and experimental, he has a true regard for the discipline of comparative anatomy which will ensure that his school will be well balanced and built upon a sound foundation. It is relevant to recall what he wrote in an article on zoology at Oxford in *Biology* in 1944: "It is indeed not comparative anatomy, but the *method* of comparative anatomy, that makes the substance of Oxford's tradition of zoology. Comparative anatomy is only part of zoology, but the method devised for its analysis is the method of all creative science in its most difficult, fallible, and in a sense most sophisticated form. In comparative anatomy, the object is not to examine diverse animal forms, which is easy, but to appraise the significance of their diversity. . . . If it has ever been said that a man trained in the methods of comparative anatomy should be able to turn his hand to most things, the variety of Oxford's useful researches in zoology does nothing to belie the judgment."

Prof. Medawar himself has a great variety of zoological interests, and his research lies along two very different lines. In one he is developing the mathematical treatment of animal form and the process of growth and ageing; in this he carries forward the pioneer work of Sir D'Arcy Thompson. His second main interest is a study of the differences between individuals. Here come his valuable researches on mammalian skin grafting, so important in their human application; his approach to the problem is both immunological and genetical. A recent development has been his discovery and investigation of the curious phenomenon of an induced spread of pigmentation when pieces of black skin are grafted into white areas of a piebald guinea-pig. Prof. Medawar has a fertile imagination combined with an ability for putting his ideas for research into practice. We look forward with confidence to the development of his Birmingham school of zoology.

František Křižík (1847–1941)

ALTHOUGH he died in occupied Prague as recently as 1941, Křižík's centenary falls this year. Born of poor parents on July 8, 1847, he was as much a man of science as an engineer. His aim in life was neither riches nor fame, but he had a constant desire to invent, to improve and to lessen the drudgery of manual labour. Obviously he had to seek a career in electrical engineering, and as a youth he attracted attention by installing a satisfactory telegraph system on the various private Central European railways that were then being constructed. As a railway engineer Křižík had plenty of scope for his inventive talent, and in 1878 he introduced a block signal system designed to prevent accidents. In 1880 he produced an electric arc lamp that gave better and more constant illumination. In the following year, opportunity was taken to show the lamp at the Paris Exhibition, where it gained first prize. Gold medals were also awarded for it at the Munich and Vienna Exhibitions of 1883, and these lamps were soon being made in Britain and used for lighting the streets of London, Paris and elsewhere. Křižík now gave up his railway appointment at Pilsen and established an electro-technical works at Prague for making not only lamps, but also dynamos and other electrical apparatus and machines. He experimented with an electrically driven train as early as 1891, the year of the Prague Exhibition, for which he was both architect and engineer. His illuminated fountain and electric railway (the precursor of many European tramways) provoked wide comment and largely contributed to the success of the exhibition.

No less than a hundred and thirty electrical power stations were constructed by Křižík, who was all the time studying electro-technical theory and applying it to problems of transport, lighting and other needs. He was critical of academic instruction in physics; for in his student days at the Prague Technical University, the whole of electro-technics was dismissed in two lectures as part of the course in electricity. In his later years he was engrossed in the expansion of his works, but was certainly active and interested in the progress of science at the time of his ninetieth anniversary. He died in the midst of the Second World War on January 22, 1941, at a time when it was impossible to pay tribute to his achievements.

British Scientific Instrument Research Association: New Laboratories

THE formal opening of the new laboratories of the British Scientific Instrument Research Association will take place on Thursday, July 10 (not July 9 as previously announced). The Minister of Supply will be the principal guest. The address of the laboratories is "Sira", Southill, Elmstead Woods, Chislehurst, Kent (Imperial 2237). Recent issues of the monthly *Bulletin* of the Association have reported on the progress made in transferring the Association's laboratories from Russell Square, London, to "Sira". The Chemical Department occupies the first floor of the new buildings, with a large main laboratory, two research laboratories, a balance room, a preparation room and ample storage space. There is also a furnace room, equipped with glass-making crucibles, away from the main building. The transfer of the Physics Department was begun last December, and it will occupy two large laboratories, a dark room and an office, all situated on the ground floor. One laboratory is equipped as a high-vacuum laboratory, with three different types of evaporation plants (Hickman, Edwards and Metro-Vickers). This section has been largely concerned in the past with the problems of production of aluminium, rhodium and anti-reflexion evaporated films. Efforts are now being directed to the production of three types of interference films: uncoloured reflexion films for beam-splitting, coloured reflexion and transmission films for coloured filtering, and strongly selective transmission filters for narrow-wave-band filters (see *Nature*, **158**, 422; 1946). The second laboratory is being equipped as a General Physics Laboratory, where problems of instrument design and manufacture, such as the measurement and control of humidity, high-temperature thermocouple measurements, and the measurement of high resistance, are to be studied.

Benjamin Franklin House

ON June 27, Mrs. Lewis Douglas, wife of the American Ambassador in London, unveiled a commemorative tablet in Benjamin Franklin House, 36 Craven Street, London, W.C.2. This is the headquarters of the British Society for International Understanding, an educational organisation which was formed early in 1939 to promote among the British people a genuine understanding about other nations. It was in this house that Benjamin Franklin, one of the founders of the American Constitution, lived between 1757 and 1775 as agent for Pennsylvania, and carried out his electrical experiments, notably on the lightning conductor, and wrote much of his work. During the Second World War, the house was severely damaged by incendiary and explosive bombs. It has, however, been restored so far as possible to its original condition, with the aid of the American Philosophical Society, the Historical Society of Pennsylvania, the Franklin Institute of Philadelphia and Miss Caroline Bache, a great-great-great-granddaughter of Benjamin Franklin.

The British Society for International Understanding, as an independent, non-party organisation, relies entirely on subscriptions, donations, the sale of literature and payment for its services, the principal of which are the publications called "British Surveys". There are two types of "British Surveys". One is the main edition, intended for adult reading, and the other the popular series which are especially written for use in schools. Each survey gives accurate, unbiased background information on a particular country or an international topic. The main edition is published fortnightly and the popular series monthly. The Society also recommends lecturers and answers inquiries about foreign affairs and the British Empire. Mrs. Douglas said at the formal opening of Benjamin Franklin House that it was appropriate that his one-time home should be dedicated as the headquarters of a Society for International Understanding, for it would be hard to point to a more international figure than Benjamin Franklin. "It is Benjamin Franklin the world citizen we salute to-day. He lived in a period of collision and war, but he always stood for union and harmony and he became one of the great representatives of international culture."

Geological Society of Turkey

The Geological Society of Turkey (Türkiye Geoloji Kuruma) was officially founded in June 1946 at Ankara. The headquarters are in the Institute of Mining Research, Ankara, and the officers are: *President*, Prof. H. N. Pamir; *Vice-President*, Dr. M. R. Egemen; *Secretary*, Dr. G. Otkun; *Treasurer*, M. Tasman. The objects of the Society are to promote geological research and encourage the study of geology, and to foster contact and collaboration between the various branches of applied geology. Its activities include conferences, lectures and discussions on geological topics; geological excursions both in Turkey and abroad; publication of a bulletin and memoirs of original research; establishment of a library; maintenance of close relations with similar bodies abroad and participation at international geological congresses. Much has already been done since the founding of the Society. Two conferences and an excursion have been held in Ankara, the first of which (February 24–28) comprised papers on local geology, including a comparison of Scotland and Turkey by Prof. W. J. McCallien, of the University of Ankara, and on petrology and geophysics, and a whole-day excursion to the Haymana region south of Ankara. Preparations are now being made for the publication of the first bulletin. The present membership is one hundred, and there are twelve foreign members and correspondents.

South-Eastern Union of Scientific Societies

The fifty-first annual congress of the South-Eastern Union of Scientific Societies will be held at Brighton during July 14–19. The Corporation of Brighton has put the Royal Pavilion at the disposal of the Congress. The president-elect is Prof. W. A. F. Balfour-Browne, who will give an address on "The Possibilities of Natural History". The sectional presidents are E. J. Bedford (botany), A. H. Toms (geology), J. E. Ray (archæology), Prof. G. D. Hale Carpenter (zoology). A morning session will be devoted to a discussion on "The Place of Scientific Societies in the Promotion of Science", based on a circular letter received from the British Association. There will be an evening public lecture and film, "The Beginning of History", dealing with British prehistory, the introductory lecture being given by E. Cecil Curwen, and a film programme for schools designed to promote interest in local natural history and archæology. The honorary general secretary of the Union is H. M. Montford, 23 Mountside, Guildford, Surrey, from whom particulars of the Congress can be obtained.

University of London

The following appointments have been announced: Dr. K. J. Franklin, acting director of the Nuffield Institute for Medical Research, Oxford, to the University chair of physiology tenable at St. Bartholomew's Hospital Medical College, as from October 1; Dr. Margaret M. A. Murray, since 1925 lecturer in physiology at Bedford College, to the University chair of physiology tenable at the College, as from October 1; Dr. Margaret Fishenden, during 1932–45 honorary lecturer in the Mechanical Engineering Department at the Imperial College of Science and Technology and since 1945 senior lecturer in heat transmission, to the University readership in applied heat tenable at the College, as from October 1; Mr. H. E. O. James, since 1926 lecturer in psychology at the University of Manchester, to the University readership in psychology tenable at the Institute of Education, as from October 1.

The title of reader in commerce in the University has been conferred on Mr. Frederick Brown, in respect of the post held by him at the London School of Economics; the title of reader in electrical engineering in the University has been conferred on Mr. C. R. Stoner, in respect of the post held by him at Queen Mary College.

The degree of doctor of science has been conferred on W. J. Martin (Birkbeck College and the London School of Hygiene and Tropical Medicine) and on K. R. S. Morris (external student).

"The Corpus Allatum and the Control of Metamorphosis in Insects"

Dr. V. B. Wigglesworth writes: "In my letter in *Nature* of June 28, p. 872, I omitted, by an oversight, any reference to the important observation by Vogt that the corpus allatum of the first-stage larva of *Drosophila hydei* will induce egg production when implanted into the allatectomized adult female (*Biol. Zbl.*, 63, 467; 1943). This provides further evidence for the identity of the juvenile and yolk-forming hormones."

Announcements

Prof. Linus Pauling, professor of chemistry in the California Institute of Technology, has been appointed George Eastman visiting professor in the University of Oxford for the Hilary and Trinity terms, 1948.

Mr. J. L. Adam, chief surveyor to the British Corporation of Shipping and Aircraft, has been elected president, and Dr. J. H. Paterson vice-president, of the Institute of Welding.

Dr. H. L. Jensen, Macleay bacteriologist of the Linnean Society of New South Wales, Sydney, has been appointed chief of the Division of Bacteriology of the State Laboratory of Plant Culture, Danish Ministry of Agriculture.

At the annual general meeting of the British Standards Institution, held on June 27, Lord McGowan, of Imperial Chemical Industries, Ltd., was elected president in succession to Lord Woolton; and Sir Clifford Paterson, director of the Research Laboratories of the General Electric Co., Ltd., chairman of the General Council in succession to Sir William Larke.

The Society of Dyers and Colourists is organising a symposium on "Recent Advances in the Theory and Practice of Dyeing" to be held at Blackpool during September 25–27. Those likely to attend are asked to communicate with the General Secretary, The Society of Dyers and Colourists, 32–34 Piccadilly, Bradford.

A conference on "Emission Spectra of the Night Sky and Auroras" is to be held in the rooms of the Royal Society during July 7–10. Among the speakers from outside Britain will be G. Dejardin, J. Dufay and R. Bernard (Lyons), D. Barbier, J. Cabannes, A. and E. Vassy, J. Bricard and A. Kastner (Paris), C. T. Elvey (Inyokern, California), J. Kaplan (Los Angeles), M. Nicolet (Brussels), E. O. Hulbert (Washington), R. Grandmontagne (Villeurbanne, Rhone), L. Harang (Tromsö), L. Vegard and C. Størmer (Oslo) and H. Alfvén (Stockholm).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Absorption Spectra with Polarized Infra-Red Radiation

Elliott and Ambrose[1] have described measurements with polarized infra-red radiation. In a previous paper[2], we have explored the use of polarized radiation in studying the absorption spectra of oriented polymers. We have now extended this work by a much-improved technique, using large selenium mirrors to obtain the polarization, and have measured the spectra of many substances between 2 and 15 μ. Particularly interesting results have been found with crystalline solids such as simpler amides, dibenzyl, benzyl and diphenyl acetylene. A small amount of the solid is melted between a pair of rock-salt plates and allowed to crystallize so as to obtain so far as possible a linear orientation of the crystal growth.

When examined in polarized radiation with the direction of crystal growth successively parallel and perpendicular to the plane of polarization, marked spectral changes were found. Bands which are weak in one case are strong in the other; it is probable that the differences would be even more marked and informative if the crystalline orientation could be made more complete. The reality of the effects is proved by replacement of the selenium polarizing mirror by a plane aluminium mirror, when all the bands appearing in either of the other two cases appear together.

A very interesting feature is noticed with some of the amides, where the stretching vibration bands of the $C=O$ and $N-H$ bonds at 1655 cm.$^{-1}$ and 3250 cm.$^{-1}$ appear strong when that of the $N-H$ deformation at 1545 cm.$^{-1}$ is weak, and *vice versa*. This could at once be explained if the amides are associated through hydrogen bridges of the type usually accepted and confirmed spectroscopically[3], namely, involving the link $-C=O\cdots H-N-$. In different amides, which may differ in their internal crystal structure and hence in the arrangement of the bridges, the effect observed varies in degree. The results therefore confirm this type of association, and also provide a new reason for attributing the band at 1545 cm.$^{-1}$ to the deformation of the $N-H$ bond, about which there has recently been some doubt. Moreover, they suggest that it may be possible to use this method in studying the structure of polyamides.

We are extending this work to unstretched and stretched rubbers, derivatives of cellulose, and nylons, with which similar changes have been found, and we are also applying it to peptides and proteins such as myosin. A detailed account will be published later elsewhere.

J. MANN
H. W. THOMPSON

Physical Chemistry
Laboratory,
Oxford.
May 13.

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[1] *Nature*, **159**, 641 (1947).

[2] Thompson and Torkington, *Proc. Roy. Soc.*, A, **184**, 3 (1945); *Trans. Farad. Soc.*, **41**, 260 (1945).

[3] Richards and Thompson, *J. Chem. Soc.*, in the press.

Polarized Infra-Red Radiation as an Aid to Crystal Analysis

THE optical properties of crystals have been widely used as subsidiary data in X-ray structure analysis. Recent advances in infra-red spectroscopy now make it possible to extend the optical measurements into the region of molecular vibrational frequencies. Since certain infra-red absorption bands of organic molecules can be assigned to vibrations largely localized in certain substituent groups, or to vibrations of the molecule as a whole, a study of infra-red dichroism gives information about the orientation of the groups or molecules in the crystal. For example, if all the molecules in a crystal are equally oriented with respect to the crystal axes, then the minimum absorption of polarized infra-red radiation will be observed when the plane of polarization contains the direction of the change of electric moment produced by the molecular vibration responsible for the absorption. If the crystal contains two sets of mutually inclined molecules, the maximum absorption occurs when the plane of polarization bisects the obtuse angle between the two planes containing the directions of the electric moments and the incident beam. From the ratio of the maximum to minimum optical densities, the angle between the planes can be calculated. Information of this sort can be obtained with the aid of an extremely simple polarizing attachment to a standard infra-red spectrophotometer.

A polarizer was constructed from two surface-aluminized concave mirrors and a plane selenium mirror. The latter was made by melting selenium between a metal plate and a plane glass plate; on cooling, the glass plate was removed, leaving a highly reflecting selenium surface. The first concave mirror was arranged to throw a parallel beam of light from a Nernst filament on to the selenium mirror at the polarizing angle, and the second mirror to condense it on to the crystal sample placed in the usual position relative to the spectrophotometer. The electric vector in the polarized beam was parallel to the length of the slit, and the sample could be rotated about the axis of the beam. The samples were prepared as thin sheets between rock-salt plates by crystallizing from the melt until a parallel growth of crystals was obtained.

The efficiency of the polarizer may be judged from the fact that the transmission of a sample of succinic acid at 2,900 cm.$^{-1}$ decreased from 75 to 1·5 per cent as the plane of polarization was rotated from the [*c*] axis to a perpendicular direction. The [*c*] axes of the acicular crystals in this sample, which was a high-temperature form of unknown crystal structure, were parallel to one another, but the crystals assumed two different orientations about this axis. The great change in absorption of the broad band extending from 3,250 cm.$^{-1}$ to 2,300 cm.$^{-1}$, due to hydrogen-bonded hydroxyl groups, indicates that the $O-H$ bonds must all be nearly parallel to one another and to the [*c*] axis. This is known to be the case in the form stable at room temperature[1].

In the case of a sample of *p*-benzoquinone, tabular on the (100) face, none of the bands showed very intense dichroism. In the crystal structure of benzoquinone determined by X-ray methods[2], the angle between the [*b*] axis and the projection of the $C=O$ bonds on the (100) plane is approximately 33°. Several of the absorption bands, including those associated with the $C=O$ and $C-H$ fundamental frequencies, exhibited dichroism corresponding to angles between 32° and 40°.

As a further test of the method, acetanilide was examined by polarized infra-red radiation, and the conclusions reached were checked by an independent X-ray examination kindly made by Mr. D. E. C. Corbridge, of these Laboratories.

In the sample examined, the crystals (space group P_{bca}) formed as needles elongated along the [*b*] axis and tabular on (100). Most of the bands exhibited a maximum absorption parallel to the [*b*] axis, but a few, including that at 759 cm.$^{-1}$ attributed to the flapping motion of the benzene ring, exhibited a maximum absorption parallel to the [*c*] axis. From the ratio of maximum to minimum optical densities of the various bands, it was calculated that the benzene rings were inclined at about 20° to the (001) plane, and the projections on (100) of the hydrogen-bonded N—H and C=O bonds were each inclined at about 30° to the [*b*] axis. From the observed optical densities, it was estimated that the C_6H_5—N bonds must lie at a fairly small angle to the [*a*] axis. These conclusions are in agreement with the general arrangement of the molecules as deduced from the preliminary X-ray study.

A further possibility, which has not yet been examined, is to reverse the process and use the infra-red dichroism of crystals of known structure to analyse the infra-red spectra or to check proposed assignments of fundamental frequencies.

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Manchester, 9.
May 2.

[1] Verweel, H. J., and MacGillavry, C. H., *Z. Kristall.*, A, **102**, 60 (1939).

[2] Robertson, J. M., *Proc. Roy. Soc.*, A, **150**, 106 (1935).

Oxidation of Neostrychnine

The action of bromine on neostrychnine, $C_{21}H_{22}O_2N_2$, in cold acid solution affords a bromohydrobromide transformed by hot water into the hydrobromide of oxodihydroallostrychnine (formerly called oxodihydroneostrychnine), $C_{21}H_{22}O_3N_2$, in nearly theoretical yield. This substance has now been recognized as an aldehyde, and its formation involves a molecular rearrangement, :N.CH = C: → :N—C(CHO):. It is noteworthy that the reverse transformation can be realized. Catalytic reduction of the aldehyde in alcoholic solution gives a dihydro-derivative, probably the related primary alcohol; in acetic acid solution an isomeride is produced in addition, and this is converted with great ease by dilute mineral acids into neostrychnine. Nitrous acid transforms neostrychnine into a ketoxime-formamide, : N.CH : C : → : N.CHO HON : C:, which is hydrolysed by dilute hydrochloric acid to hydroxylamine, formic acid and a hydrochloride, $C_{20}H_{23}O_3N_2Cl$. This is a salt of a *sec*-basic ketone.

Taking into consideration what is already known in regard to the environment of the basic nitrogen of strychnine, these observations establish the relation of neostrychnine to strychnine. Under the influence of Raney nickel (and in other ways in certain derivatives), the double bond moves just one step in the direction of the basic nitrogen atom. This implies a new view of the methoxylating fission of the metho-salts of the alkaloids.

The direct explanation of the formation of oxodihydroneostrychnine (now termed oxodihydroallostrychnine) and its reconversion to neostrychnine was

$$\text{—CH:C(N:).} \rightarrow \text{—CO.CH(N:).} \rightarrow \text{—CH(OH).CH(N:).} \rightarrow \text{—CH:C(N:),}$$

and on this basis the older type of formula for strychnine was untenable. The discovery of unexpected and somewhat remarkable molecular rearrangements disposes of this natural explanation. It does not disprove the quinuclidine formula recently proposed[1]; but it removes the necessity for its postulation and, in these circumstances, we revert, as the best hypothesis to guide future work, to an earlier suggestion[2]. The relation of this structure to that of cinchonine has already been indicated[3]. Several slight modifications of this expression are feasible, and these have special advantages and disadvantages which must be discussed at a later date, especially since it is probable that crucial experimental tests can be devised.

R. N. Chakravarti
R. Robinson

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South Parks Road,
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May 19.

[1] Robinson, R., *Nature*, **159**, 263 (1947).

[2] Robinson, R., *Experientia*, ii, 1, 28 (1946). Briggs, L. H., Openshaw, H. T., and Robinson, R., *J. Chem. Soc.*, 903 (1946).

[3] Openshaw, H. T., and Robinson, R., *Nature*, **157**, 438 (1946).

Fluorescence of Cancerous and Non-Cancerous Lipoids

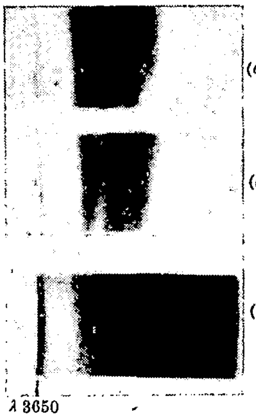
In a previous communication, evidence was given[1] indicating the presence in human cancer tissue of a fraction, or fractions, the fluorescent spectra of which were similar to, if not identical with, those produced by methylcholanthrene. The fluorescence produced in a similarly treated lipoid fraction obtained from non-cancerous livers was considerably weaker, and appeared in a different region of the spectrum.

These findings were disputed by Hieger[2], and, in an exhaustive study of lipoids obtained from human cancerous and non-cancerous livers, Jones and May[3] failed to identify any methylcholanthrene-like compounds in human cancer tissue.

It should be emphasized at the outset that the expression 'methylcholanthrene-like' referred specifically to the similarity of the bands produced by the two substances. However, since even the existence of such bands in cancerous liver lipoids was questioned, the present work was undertaken to check the original contention, and to secure a more satisfactory procedure for the isolation and concentration of the material giving the banded fluorescent spectrum. A method was finally developed which has given fairly consistent results. Briefly stated, the procedure is as follows.

The acetone-soluble fraction is obtained as already described[4]. This lipoid is then saponified with 10 per cent potassium hydroxide in 70 per cent ethanol in a ratio of 1 : 10 for 24 hours. The ethanol is removed, the residue taken up in ethyl ether, and washed with distilled water until neutral to litmus. The solvent is then removed and the residue resaponified for four hours. The final residue is taken up in acetone and a part of the free cholesterol removed by refrigeration and filtration. After the removal of the acetone, the residue is taken up in hexane, passed through a column of activated alumina, and developed with hexane. This resolves the lipoid into three main fractions: (1) the upper third of the column is occupied by a light brown to yellow zone; (2) a light-bluish fluorescent zone comprising the rest of the column; (3) a filtrate. The column is then partly dried by air, the two fractions separated, extracted repeatedly with methanol, and filtered. The methanol is removed under reduced pressure and the residue taken up in hexane. The yellow material (top zone) is then passed through a column of silicic acid. This resolves the lipoid into four to six bands of various gradation of brown (from dark to light), a pink and red band, and on repeated washing, a zone of blue fluorescence at the bottom of the column. The lower fraction is separated, extracted with methanol, which is later removed at reduced pressure, the residue is taken up in hexane, and photographed as previously described[1]. An alternate procedure is to treat this fraction by repeated washings with hexane, and recover it from the filtrate.

As to the other fractions appearing in the column, they give either a continuous spectrum or are non-fluorescent. Quantitatively, the recovery of this material varies. In a typical instance, about 2,400 gm. of tissue will yield 56 gm. of total lipoid. Upon saponification the latter will give 1·5 gm. of unsaponifiable material. After passing it through a column of activated alumina, and then through a column of silicic acid, the material will give 15 mgm. of bluish fluorescent material, producing the characteristic spectroscopic banded structure.



(a) FLUORESCENCE OF FRACTION FROM CANCEROUS TISSUE; (b) FLUORESCENCE OF METHYLCHOLANTHRENE; (c) FLUORESCENCE OF FRACTION FROM NORMAL TISSUE

The results illustrated by the figures are self-explanatory. The bands obtained from the cancerous unsaponifiable fraction show a slight shift toward the 3650 mercury line, and do not agree exactly with the bands produced by methylcholanthrene. On all three spectrograms the long wave-length is to the right of the 3650 line of mercury. The 'bands' in (a) are shifted slightly to the violet relative to those in (b). When the originals of (a) and (c) are compared it looks as if the same bands occur on the two plates. The intensity of the fluorescence in the normal is too low to prevent the mercury lines 4047, 4074 and 4358 from coming through. That, and a shift of intensity toward the red, gives us the difference in the two plates. It seems reasonable to conclude that the fluorescences in (a) and in (c) arise from the same substance. The substance is present in greater amounts in cancerous than in non-cancerous material.

The comparison with methylcholanthrene does not imply the presence in the cancerous lipoid of a fraction identical with the known carcinogens. It indicates: (1) the presence of substances giving banded structures in the unsaponifiable fraction obtained from cancerous livers, and, to a certain extent, in non-cancerous livers; and (2) the close similarity between the bands obtained from a fraction endogenous in character, and a synthetically prepared exogenous compound.

This material was found on analysis to consist largely of a saturated hydrocarbon which on catalytic micro-hydrogenation failed to take up hydrogen. Since the saturated hydrocarbon could not be responsible for the fluorescence, it is evident that the latter is due to a component or 'admixture', and present in a relatively very small amount. Investigation of this fraction is now in progress.

This work was repeated and confirmed by Dr. B. Krichesky, associate professor of zoology, at the University of California, at Los Angeles. A detailed report of the method employed will be published elsewhere.

These investigations were supported by a grant from the Jewish Fund for Medical Research to the University of California and carried out under the supervision of the Committee on Cancer Research.

H. S. Penn

Department of Zoology,
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Joseph Kaplan

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March 13.

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[1] Penn, H. S., *Nature*, **149**, 193 (1942).

[2] Hieger, I., *Nature*, **149**, 300 (1942).

[3] Jones, R. Norman, and May, C. D., *Cancer Res.*, **4**, 304 (1944).

[4] Penn, H. S., and Jacobsen, Elly N., *J. Immun.*, **54** (Sept. 1946).

Molecular Compounds Involving Copper Diphenylacetate

The copper salts of many organic carboxylic acids are soluble in alcohol (see Beilstein). It has now been found that although a few are soluble in benzene, for example, copper hydrocinnamate, many which are insoluble in benzene will dissolve readily on addition of a few drops of alcohol; for example, copper phenylacetate, diphenylacetate, *o*-toluate.

Copper diphenylacetate has been studied in more detail. This compound crystallizes from hot absolute alcohol in large light-green octahedral crystals containing two molecules of alcohol. The combined alcohol is lost on standing in the open, and the crystals become darker in colour without apparent change in form. The light-green material containing alcohol is readily soluble in benzene, whereas the darker green compound is not. If copper diphenylacetate is crystallized from aqueous alcohol, needle crystals are obtained without alcohol, and these are insoluble in benzene.

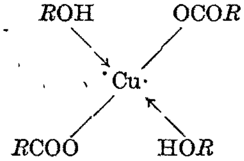
It would seem from this that the substance possessing benzene solubility is $CuA_2.2EtOH$ (where A is the diphenylacetate radical). The molecular weight of this compound determined cryoscopically in benzene varied from 350 to 430 with the concentration. This is lower than the calculated value of 578, but shows that there is only one atom of copper in the molecule.

Copper diphenylacetate combines with many other alcohols. The following have been investigated :

Alcohol	Crystalline form	Mols. alcohol : mols. CuA_2
PRIMARY		
Methyl	—	no compound isolated
Ethyl	octahedra	2 : 1
n-Propyl	octahedra	2 : 1
n-Butyl	octahedra	2 : 1
n-Amyl	octahedra	2 : 1
n-Octadecyl	—	no compound isolated
iso-Butyl	octahedra	2 : 1
Allyl	octahedra	2 : 1
Benzyl	needles	2 : 1
SECONDARY		
iso-Propyl	—	no compound isolated
sec-Butyl	prisms	indefinite
cyclo-Hexanol	needles	1 : 1
TERTIARY		
tert-Butyl	plates	2 : 1
Amylene hydrate	needles	1 : 1
Triphenylcarbinol	—	no compound isolated

The last two compounds with tertiary alcohols are remarkable in being quite stable in contact with the atmosphere.

In the 2 : 1 compounds, it is probable that the alcohol molecules are linked to the copper atom by donation of electrons from their oxygen atoms :



Cis and *trans* arrangements would be possible if the copper atom had the usual planar valency distribution. These have not so far been observed.

The combining powers of copper diphenylacetate are not restricted to alcohols. Acetone gives a 1 : 1 compound (plates), ethyl acetate a compound of indefinite composition (plates), aldehydes dissolve copper diphenylacetate very readily, and pyridine gives a 1 : 4 compound (azure hexagonal plates).

Publication in full will be made elsewhere. The comparative solubility of copper salts of organic acids is being investigated.

MALCOLM CRAWFORD

Wigan and District
Mining and Technical College.

April 11.

Highly Active Triphenylethylene Derivatives

TRIPHENYLETHYLENE[1] and several active derivatives[2-4] have been shown to possess a prolonged œstrogenic activity provided that a dose well above the threshold is administered. Among these, αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene[4] has been especially noted for its considerable prolonged œstrogenic activity when administered orally. A considerable prolonged action has also been noted[5] when a dose well above the threshold of diethylstilbœstrol dimethyl ether is administered subcutaneously. Emmens[6] has attributed the prolonged action shown on injection of the higher doses of methyl ethers of diethylstilbœstrol and of œstrone to "the slowness with which the body effects hydrolysis of such ethers, without which they cannot be esterified and excreted".

αα-Di-(*p*-hydroxyphenyl)-β-phenylbromoethylene (m.p. 205–7°) has been found to possess, when administered by subcutaneous injection, a relatively high potency; but the duration time, like that of diethylstilbœstrol[5], is not appreciably increased with increased dosage. When administered by subcutaneous injection, its diacetate ester (m.p. 157–159°) has a more prolonged action, and its minimal effective dose is lower. In contrast to αα-di-(*p*-ethoxyphenyl)-β-phenylbromoethylene, which is a pro-œstrogen[7], both αα-di-(*p*-hydroxyphenyl)-β-phenylbromoethylene and its diacetate ester have been found to be true œstrogens.

αα-Di-(*p*-hydroxyphenyl)-β-phenylbromoethylene is readily obtained from αα-di-(*p*-isopropoxyphenyl)-β-phenylbromoethylene (m.p. 116–118°). The latter is prepared by brominating αα-di-(*p*-isopropoxyphenyl)-β-phenylethylene (m.p. 83–84°). On heating αα-di-(*p*-isopropoxyphenyl)-β-phenylethylene in vacuum at 220–230° with a drop of 20 per cent sulphuric acid, αα-di-(*p*-hydroxyphenyl)-β-phenylethylene (m.p. 178°) is obtained in quantitative yield. αα-Di-(*p*-acetoxyphenyl)-β-phenylethylene (m.p. 84°) and αα-di-(*p*-propionoxyphenyl)-β-phenylethylene (sinters at 62° and melts at 65–66°) are obtained by heating αα-di-(*p*-hydroxyphenyl)-β-phenylethylene with acetic anhydride and propionic anhydride respectively. αα-Di-(*p*-acetoxyphenyl)-β-phenylbromoethylene has been prepared by brominating αα-di-(*p*-acetoxyphenyl)-β-phenylethylene.

The œstrogenic activity of some triphenylethylene derivatives is shown in the accompanying table. The substances were dissolved in oily solution.

Substance	Subcutaneous injection		Oral administration (stomach tube)	
	Dose (μgm.)	Duration until action halved (days)	Dose (μgm.)	Duration until action halved (days)
αα-Di-(*p*-hydroxyphenyl)-β-phenylethylene	50 75 100 200 375 750	Slight effect 2 2 3 3 4	1000	Nil
αα-Di-(*p*-hydroxyphenyl)-β-phenylbromoethylene	1 2 10 15 100	Nil Slight effect 4 5 8	10 20 25 50 100	Slight effect 3 3 3 3
αα-Di-(*p*-acetoxyphenyl)-β-phenylethylene	1000	9		
αα-Di-(*p*-acetoxyphenyl)-β-phenylbromoethylene	0·2 0·5 1 2 10 1000	Slight effect 5 5 5 9 24	10 50	3 6
αα-Di-(*p*-ethoxyphenyl)-β-phenylbromoethylene			10 50 500	7 21 38
αα-Di-(*p*-propionoxyphenyl)-β-phenylethylene	100	6		
αα-Di-(*p*-isopropoxyphenyl)-β-phenylbromoethylene	100 1000	6 128		

One of us (W. T.) would like to express his gratitude to Prof. E. E. Turner for offering facilities to carry out chemical work in the Chemistry Department, Bedford College, University of London, during his stay in England. He would like also to thank Prof. A. Schönberg, Chemistry Department, Faculty of

Science, Fouad I University, Cairo, for his interest in the progress of the work. The expenses of this investigation have, in part, been defrayed by a grant from the Medical Research Council (to J. M. R.).

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A Volatile Compound of Copper

IN search of the cause of a copper deposit formed in some incandescent lamps with copper electrodes, we examined the thermal decomposition of some organic copper salts. Cuprioxalate yields copper oxides, and cuprimesoxalate a mixture of copper oxides with elementary carbon. Cupriformate, however, decomposes at about 200° C., evolving partially a volatile compound of copper which immediately decomposes, forming a red smoke of elementary copper, and coating the near hot glass surface with a brilliant mirror of metallic copper. Where this mirror was thin, it resembled in every way the red deposit found in incandescent lamps.

Cupriformate may be decomposed in a horizontal glass tube in a stream of non-oxidizing gas, and its volatile product of decomposition is thus carried quickly out of the hot zone and saved from decomposition. It may be transported by the gas through a dense filter of cotton wool several centimetres long in a glass tube over a distance of more than 40 cm., and if the gas is ignited there, the new compound makes the flame an intense green. If, however, a remote part of the tube through which the compound is swept by the gas is heated externally, a beautiful copper mirror is formed. The unheated part of the tube between the cupriformate and the heated section remains absolutely clear. In a preliminary experiment, more than 1 per cent of the copper present in the decomposed cupriformate was recovered in the remote mirror. This reaction is useful in the quantitative study of the behaviour of the new compound, the isolation of which has not yet been accomplished. It is readily adsorbed on glass wool and to some extent on cotton. It condenses together with droplets of water—resulting from the formate—on the glass tube, and may be driven thence by gentle heating. The diluted gas stream is uncoloured; but around the decomposing cupriformate the gas phase is sometimes olive-green.

Formates of nickel, iron, cobalt, zinc and cadmium decompose without mirror formation. The extremely labile silver formate, however, yields a mirror on thermal decomposition, and silver oxide does the same when heated in a stream of reducing gas containing formic acid vapour. It is interesting that this reaction of the formates is not observed with the carbonyl-forming metals but occurs with two metals of the first sub-group of the periodic system. Experiments with gold are in progress. *Feb.* 21.

The existence of a copper carbonyl has been already postulated[1-4] but was seemingly disproved by Mond and Heberlein[5], who found no copper mirror in a glass tube after passing a mixture of carbon dioxide and monoxide over cupric oxide. In a recent communication in *Nature*, H. Bloom[6] reports having confirmed Bertrand's[2] original claim. His experiments are convincing in respect to the formation of a volatile copper compound, which is probably identical with the one formed from cupriformate. The term 'copper carbonyl', however, needs further examination. At the beginning we also thought that we were dealing with a carbonyl, but the facts that (1) the formates of the carbonyl-forming metals are inactive and (2) that of the three copper salts examined the two yielding carbon monoxide and dioxide were inactive, and only the formate, which contains hydrogen, was found active, made us hesitate. Experiments quite similar to those of Bloom showed mirror formation only if at least traces of organic compounds containing hydrogen were present in the gas. Metallic copper never reacted, only the oxide, and that only if a reducing gas was used. It would be very interesting to repeat Bloom's experiment with carbon monoxide carefully purified from all traces of hydrogen compounds. Convincing evidence will be available only after isolation and analysis of the new compound. Experiments to this end are in progress.

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R 289

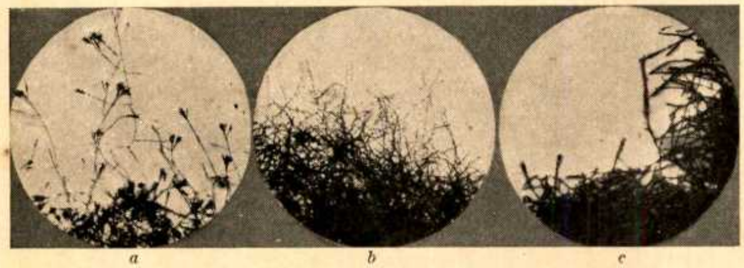
Action of 2-Aminofluorene on Moulds

Bielschowsky and Green[1] have noticed that 2-aminofluorene at a concentration of 1 : 10,000 is a growth inhibitor for *Staphylococcus aureus*. Such observations have been confirmed[2] and amplified by us. The influence exercised by this compound on two strains of *Penicillium* studied by us seems to us to be of particular interest.

Penicillium notatum Westling, strain 1219, is considerably hindered in its growth by saturating with 2-aminofluorene the Czapek–Turley medium, in which this substance dissolves only in traces. It is necessary first to sterilize the aminofluorene and then add it to the medium, otherwise the composition would be changed by heating. It seems that only sterile hyphæ are formed; there is no formation of characteristic conidiophore filaments. The hyphæ in coloured preparations appear to end with simple club-shaped swellings, or are reduced to fragments without causing the formation of conidia (see photographs); only very slowly does a sign appear of the formation of exospores.

At the second subculture, the growth on the surface is very seriously hindered, the mould developing mainly in the shape of isolated colonies at the bottom of the culture medium. At the same time, there are some modifications in the aspect of the culture, which shows a white colouring on the surface, without any sign of the characteristic blue-green colour on the surface of the crests of the folds as in the parent strain, while the mycelium on the reverse side takes a pink colour instead of golden yellow as in the original culture. The solution is much less intensely and much more slowly coloured, the production of penicillin being strongly hindered.

A somewhat different behaviour was shown by another variety of *Penicillium* isolated in this laboratory which secretes a bacteriostatic substance, active not only on Gram-positive organisms (staphylococci) but also on Gram-negative ones (typhus, cholera, etc.), that is, on micro-organisms against which the 2-aminofluorene has no bacteriostatic action. This mould, cultivated on mediums with 2-aminofluorene, also grows first without formation of conidia and looks like a white felt made of intertwined sterile hyphæ; but it accommodates itself more rapidly, and the conidiophore filaments with globular conidia of a characteristic dark green colour soon appear in isolated, later on confluent, zones. At the same time, and suddenly, the metabolism solution becomes a reddish-brown colour of a more intense hue, as compared with the control cultures cultivated on Turley medium of the same age. In successive transplantations the pigment appears more rapidly and is more intense, and the formation of the conidia seems to be less hindered, though the whole culture shows signs of suffering. A characteristic is the behaviour of the bacteriostatic action, which in the metabolic solutions of the moulds, cultivated on medium to which 2-aminofluorene has been added, appears after some delay, but reaches higher values and persists much longer, at least in the first transfers, both with Gram-positive and Gram-negative micro-organisms.



Pen. notatum WESTLING. CULTURE 4 DAYS OLD. × 25. *a*, PARENT STRAIN ON TURLEY'S MEDIUM; *b* and *c*, GROWTH ON TURLEY'S MEDIUM WITH 2-AMINOFLUORENE

Besides the bacteriostatic action on the pyogenic staphylococcus observed by Bielschowsky, the 2-aminofluorene, therefore, interferes also with the metabolism of the moulds by hindering the formation of the exospores, modifying their mode of living, in some cases exciting and in others inhibiting the production of bacteriostatic substances.

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[1] *Nature*, **149**, 526 (1942).

[2] *Farmaco*, in the press.

Pteroylglutamic Acid in Liver Extracts and Urine

IN order to undergo pupation and emergence, the larva of *Aedes ægypti* L. is dependent on the presence of 'folic acid' in the medium[1]. The use of water-extracted yeast residue makes it possible to replace the 'folic acid' of Williams by synthetic pteroylglutamic acid (*L. casei* liver factor) but not by thymine (in quantities up to 1 gm. per l. of medium) or by xanthopterin[1,2]. On the basis of these findings, we have used the metamorphosis of mosquito larvæ as a test for pteroylglutamic acid in liver extracts and urine.

Commercial liver extracts were tested at levels of 20 ml. ('crude' extracts) and 8 ml. ('refined' extracts) per l. of medium. Six liver preparations of established clinical potency were used, but only four were found capable of inducing pupation and emergence of the larvæ. The results for the three best 'refined' extracts were as follows:

Extract	Dry matter content	Larval response
A	170 mgm. per 1 ml.*	Strongly positive
B	140 mgm. per 2 ml.	Weakly positive
C	30–40 mgm. per 1 ml.	Negative

* The volumes quoted in each case represent 100 gm. fresh liver.

These observations may be accounted for on the basis of the different contents of pteroylglutamic acid, which do not appear to be related to the level of anti-pernicious anæmia factor present. Furthermore, the fact that a potent preparation such as *C* gives no larval response indicates that the anti-pernicious anæmia factor is incapable of bringing about pupation and emergence of mosquito larvæ.

Concentrates from 24-hour specimens of urine were prepared by a modification of the method of Wilkinson, Klein, Ashford, Jones, Mainwaring and Aylward[3]. In the urines of seven normal subjects, two of whom were tested twice, no pteroylglutamic acid could be detected. This result is in keeping with the observations of other workers[4-6], who found by microbiological assay that only a trace of 'folic acid' is excreted in human urine. In three of our normal subjects, assay by means of *S. lactis R*[7] showed the 24-hour urinary excretion of stimulating factor to be less than 0·6 μgm.

Four normal subjects were each given a course of liver injections intramuscularly, two receiving extract *A* and the others extract *C*. The total volumes administered in this way were 6 ml. and 8 ml. respectively. Twenty-four hour urine specimens were collected immediately following the termination of the liver treatment and again two weeks later. In all cases the larval response was negative, indicating that the excretion of pteroylglutamic acid had remained low. Over a long period it was found possible to carry out tests on similar lines on nine untreated patients with pernicious anæmia, each case being carefully investigated to establish the correctness of the diagnosis. The mosquito larva test was applied to the urine of these patients before and after liver therapy. The results are summarized below. As a negative control may be cited a case of myxœdema associated with macrocytic normochromic anæmia, which before and after thyroid and liver treatment showed little or no excretion of pteroylglutamic acid.

Although the number of cases investigated falls far short of what is desirable, there is a strong indication that clinical response to liver therapy is followed by greatly increased excretion of pteroylglutamic acid; that this increase bears no relation to any pteroylglutamic acid which may be present in the liver extract used; and that when liver is administered to normal or non-responsive subjects, pteroylglutamic acid excretion remains at a low level. The possibility of a dynamic relationship between pteroylglutamic acid and the anti-pernicious anæmia factor suggests itself.

Patient	M. larva test before treatment	Liver extract used*	Clinical response	M. larva test following treatment
1	–	*A*	+	+
2	–	*C*	+	+
3	±	*C*	+	+
4	–	*C*	+	+
5	±	*C*	+	+
6	–	*B*	+	–
7	–	*B*	–	–
		A	–	–
8 and 9	–	No further urine specimens secured.		

* The volumes of extract given were: *A* 3 ml., *B* and *C* 6–8 ml.

We should like to express our indebtedness to Prof. R. J. Williams for a specimen of 'folic acid' and to Dr. E. L. R. Stokstad for a supply of pteroylglutamic acid. Our thanks are also due to all those who co-operated in the collection of urine specimens, and to Miss M. Currie, Miss S. Sussman and Mr. J. M. Thorp for technical assistance.

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April 13.

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Dependence of Anomaloscope Matching on Viewing Distance or Field Size

FOR the rapid detection of defective colour vision in personnel untrained in the use of optical instruments, an anomaloscope has been constructed in which a bipartite test field of 18 mm. diameter is viewed direct with both eyes. One half of the field is illuminated by light passing through a narrow-cut yellow filter (Ilford No. 812, maximum transmission at 580 mμ), and the other half by a variable mixture of the lights from a narrow-cut red filter (Ilford No. 608, transmitting above 640 mμ) and a narrow-cut green filter (Ilford No. 807, maximum transmission at 530 mμ). The instrument was designed so that the proportions of red and green light in the mixed half of the field could be obtained with fair accuracy from the reading of a single scale, and a control was provided for adjusting the brightness of the other half of the field. The brightness of the field was about 10 candles per sq. metre, permitting observations to be made in artificial light or dim daylight.

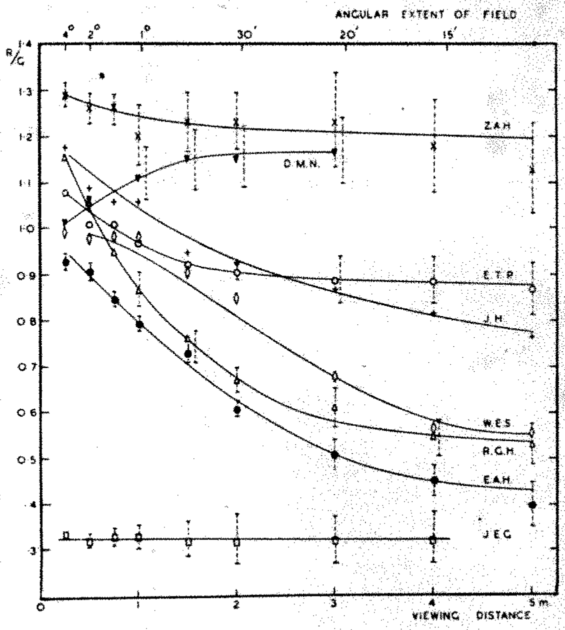

Fig. 1

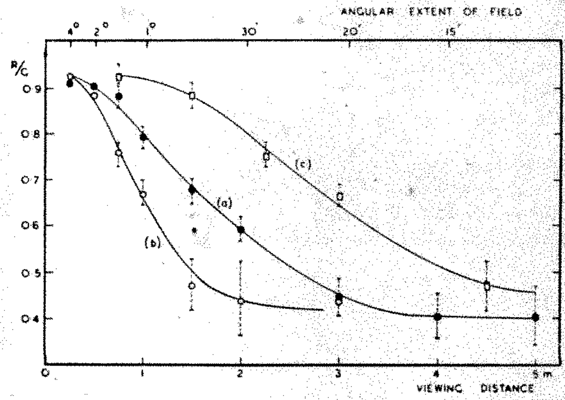

Fig. 2

It was found that the relative amount of red and green light (R/G) required to match the yellow was dependent on the viewing distance. The effect was so striking that most people, when shown their own 50-cm. match at a distance of 2 or 3 metres, at first believed the controls to have been altered.

Variation of the R/G ratio with viewing distance for a number of observers is shown in Fig. 1. In plotting these results, the average value of the ratio obtained by normal observers for a 2° field (that is, at 50 cm.) has been adjusted to equal unity. Where confusion would not thereby be introduced, dotted lines have been added to indicate the range outside which the observer definitely refused to accept any ratio as a match. It seems that individual observers show considerable differences in their types of behaviour, and that a group of observers who would be judged as normal at a short distance give widely different values of R/G at the longer distances even when allowance is made for the reduced precision. For most observers the amount of green required in the mixed field increases with the distance, and it will be noticed that the normal observer, E. A. H., requires almost as much green as the deuteranomalous observer, J. E. G., when the distance is increased beyond 3 metres.

Fig. 2 shows the results obtained by a reliable observer with a normal 18-mm. field, curve (*a*), and with a 6-mm. field, curve (*b*), plotted on the same distance scale. Curve (*c*) also applies to the 6-mm. field, but is plotted on the same angular scale as (*a*). It appears that the R/G ratio is not determined solely either by the viewing distance or by the angular extent of the field. Difficulties of accommodation and fixation, and visual aberrations, may be responsible for divergencies which, if absent, would allow the ratio to show a simple dependence on the angular extent of the field.

Whether this is true or not, it would seem desirable that investigators carrying out field inquiries with anomaloscopes of this class should pay some attention to the field-size and the viewing distance of the instruments they employ.

In view of the known peculiarities of colour vision within the central fovea, it is not surprising that effects of the type described should be found with angular fields of, say, less than 30′. It is more surprising that such effects should extend to angular fields between 1° and 3°, within which the colour-matching properties of the fovea are usually assumed to be independent of the field size.

We have asked many people if they have observed this effect before, but only Dr. J. H. Shaxby appears to have noticed it. He observed the effect when constructing his anomaloscopes, and agrees with us that it can only be because such instruments are generally fitted with eyepieces, and therefore have a fixed angle of view, that the effect is not more widely known.

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E. T. Purslow

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Mr. R. G. Horner and Mr. E. T. Purslow have made a detailed study of the fact that the red-green ratio required to match a given yellow in the anomaloscope is dependent to a marked extent upon the distance of viewing (or the angular field). I observed this effect in my anomaloscope[1], and one of my students made a study of it. He is now unfortunately inaccessible, being in the Navy, and I am unable to quote his measurements; but his findings were approximately those given by Horner and Purslow, namely, a rapid change in the ratio at small distances, settling down to a constant value where the distance is large, that is, the angular field sufficiently small.

The peculiarities of central foveal vision alluded to by Horner and Purslow are presumably largely responsible for the change; though it must be noted that in my instrument the actual ratio of red to green light in the observed field must tend to vary with distance owing to the unequal scattering of green and red by the 'Diffusalyte' glass and the restriction of the light viewed to a smaller and more definite angle at greater distances.

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[1] *J. Sci. Instr.* **22**, 15 (1945).

Shock Wave in Glass

During tests with an experimental high-speed camera developed at the National Research Laboratories[1], the photographs reproduced herewith (Fig. 1) were taken of a shock wave travelling through glass. The pictures indicate that the wave must travel through the glass at a speed of more than 18,500 ft. per sec.

The method of generating the shock wave is shown in Fig. 2. A 0·010-in. diameter copper wire was sealed through a 3/8-in. diameter × 10 in. long 'Pyrex' glass rod as shown. The copper wire was exploded electrically by discharging through it a 4 Mfd. condenser charged to 10,000 volts. An inch scale was marked on the illuminated background to facilitate measurement of velocity.

The high-speed photographs were taken in the order *A*-9, *A*-10, *B*-1, *B*-2, etc., with a time-interval between successive pictures of 15 micro-sec. A piece of black paper was placed in the lower right corner of the field to mask the flare from the exploding wire. This mask is seen in the photographs, obscuring the glass rod up to one inch above the wire.

The copper wire is seen to explode in picture *B*-3. In *B*-6, that is, 45 micro-sec. later, the upper end of the rod 10 in. away has been shattered. This implies that a shock wave travels along the glass with a speed of at least 18,500 ft. per sec. It is also apparent from the photographs that the glass does not shatter until some time after the shock wave

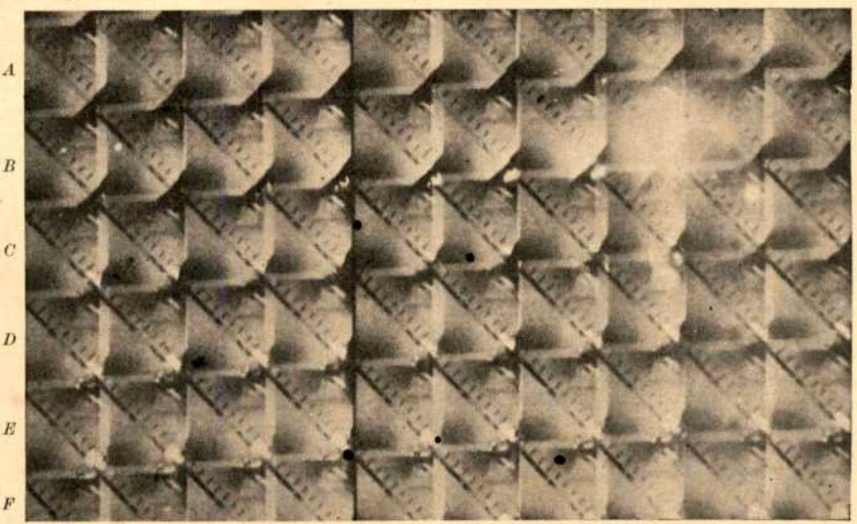

Fig. 1

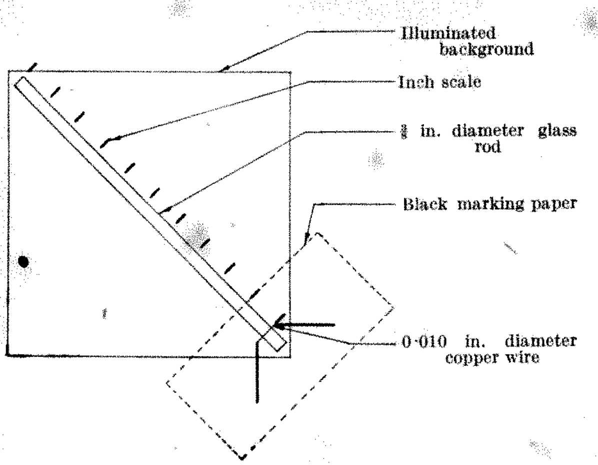

Fig. 2

has passed. It will be noted, for example, that the part of the rod three to four inches from the upper end has not broken until some time after the portions on either side of that region. Further, the time between the explosion and the shattering of the glass 3 in. from the lower end is considerably greater than the time between the shattering at the latter place and that at the upper end 7 in. farther along, that is, the shattering does not proceed along the rod with a definite velocity. It is inferred from this that after the shock wave has passed, the glass proceeds to shatter in the places where stresses are already concentrated, for example, at the end of the rod, or where annealing was poor. Thus the speed of the shock wave itself may be considerably greater than 18,500 ft. per sec. Indeed, the time between shattering at the 3-in. mark and the 10-in. mark is only 15 micro-sec., corresponding to a velocity of almost 39,000 ft. per sec.

Some portions of the rod as long as an inch were intact after the experiment, having apparently transmitted the very violent shock without fracturing. The portions that show opaque in the photographs were reduced to pieces the size of particles of sand.

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Dec. 19.

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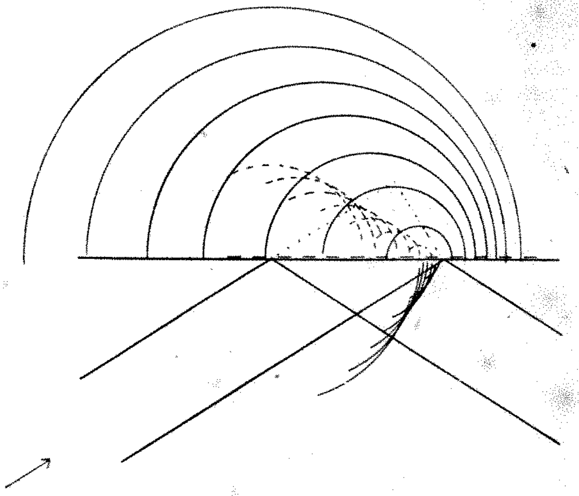
[1] Baird, K. M., *Canad. J. Res.*, A, **24**, 41 (1946).

Total Internal Reflexion and Huyghens' Construction: the Immersion Grating

It is not uncommonly supposed that if light falls on a dense-rare interface at more than the critical angle, no energy can penetrate into the rarer medium. Several workers[1] have shown that a certain amount of energy can penetrate a short distance, but that the disturbance is much attenuated and becomes negligible at a few wave-lengths distance from the interface. This is in accordance with Huyghens' construction[2] (see diagram, full circles), which gives in this case a series of secondary wavelets lying wholly within their neighbours, and hence not cutting and reinforcing at any considerable distance.

These secondary wavelets in the rarer medium can be made sensible and clearly visible by the use of a 90°, 45°, 45° prism (kindly prepared by the British Scientific Instrument Research Association), which has an array of opaque silver squares on its hypotenuse face, the intervening spaces being strips of clear glass-air interface. The silver suppresses some of the secondary wavelets, allowing the others to reinforce each other, in a number of directions, given by the generalized equation for an interfacial grating:



HUYGHENS' CONSTRUCTION FOR TOTAL INTERNAL REFLEXION
Full circles, conventional construction. Broken circles, showing wavelets emerging from a grating and reinforcing each other in the rarer medium

$$\frac{n\lambda}{d} = \mu_1 \sin\theta_1 + \mu_2 \sin\theta_2, \qquad (1)$$

where d is the grating space, λ the wave-length, n an integer, θ_1 and θ_2 the angles between the incident and emergent light and the normal in media of refractive index μ_1 and μ_2. θ_1 and θ_2 have the same sign if they are on the same side of the normal. The process is shown by the dotted circles in the diagram, which have been drawn an integral number of wave-lengths inside the corresponding and concentric full circles, with centres at the clear points of the interfacial grating.

If the treated prism is placed on the table of the spectrometer with the light incident at slightly less than the critical angle, the ordinary refracted beam (= zero order spectrum) emerges in the usual way and is clearly recognized by its intensity. If the prism be now turned slowly on the table to increase the angle of incidence, the refracted beam being followed in the telescope, the refracted beam disappears as expected when the angle of incidence becomes critical, but the higher order of spectra remain. In this way spectra have been observed emerging when the angle of incidence exceeds the critical by 25′ of arc.

A study of equation (1) suggests several possibilities. First, the device can be used for suppressing the zero order of a set of spectra or any other Fraunhofer diffraction pattern. Secondly, by putting μ_1 and $\mu_2 \sim 1{\cdot}7$, and θ_1 and θ_2 both positive and 65–70°, we can push up the value of the right-hand side to ~ 3. Thus if a very fine grating ($d \sim \lambda/3$) could be ruled on a transparent base of high refractive index, and a sandwich made of it with two prisms and liquid films of suitable refractive index, one could calibrate it using an optical spectrum in the first order. For contrast, μ_1 and μ_2 should both be high but different. Such a grating could then be used in the ultra-violet and soft X-ray region with added confidence. It could be called an 'immersion grating'.

Since a dense-rare interface becomes permeable to undulatory energy if ruled with a grating, it is clear that the classical explanation[3] of the production of X-ray spectra by glancing 'total internal' reflexion from a ruled glass or metal surface requires reconsideration.

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May 7.

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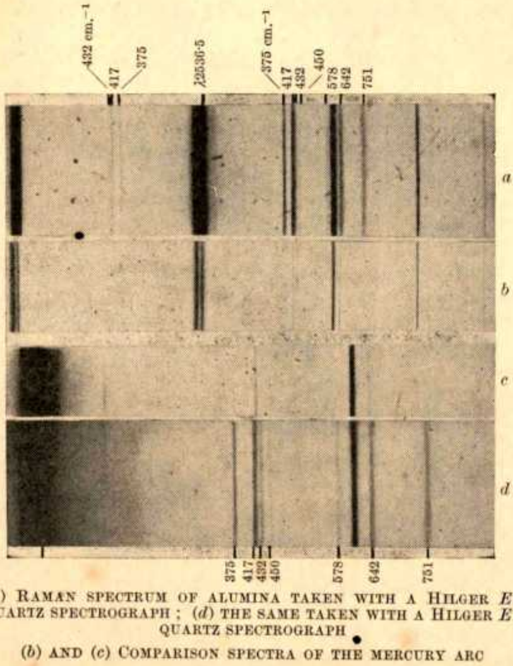
[1] Wood, R. W., "Physical Optics" (Macmillan, 1934), chapter 12, p. 418 *et seq.*, gives a summary of this work.

[2] Airy, G. B. "Undulatory Theory of Light" (Macmillan, 1877), par. 35, p. 33, Fig. 10.

[3] Compton and Allison, "X-Rays in Theory and Experiment" (Macmillan, 1935), pp. 40 and 690.

Raman Spectrum of Alumina and the Luminescence and Absorption Spectra of Ruby

STUDIES of the Raman spectrum of crystalline alumina are rather scanty and incomplete, evidently because of its comparative feebleness and a continuous fluorescence accompanying it. Deutschbein[1], who was the first to investigate the case, recorded only a single frequency shift of 415 cm.$^{-1}$. Later, a second Raman line with a frequency shift of 376 cm.$^{-1}$ was noticed by Miss A. Mani[2]. A subsequent unpublished investigation by the latter[3] gave a hint of the existence of other faint lines besides the two already reported, among which two with frequency shifts 752 cm.$^{-1}$ and 633 cm.$^{-1}$ appeared most definite. It seemed likely that the use of the intense λ 2536·5 mercury resonance radiation as exciter would yield a much more satisfactory Raman spectrum for the substance. This hope has been realized in the present investigation. A large boule of synthetic alumina presented to Sir C. V. Raman by the Linde Air Products Co. of New York gave satisfactory results: unlike the majority of samples of synthetic alumina, this particular one did not become coloured under ultraviolet irradiation.



(*a*) RAMAN SPECTRUM OF ALUMINA TAKEN WITH A HILGER *E*3 QUARTZ SPECTROGRAPH; (*d*) THE SAME TAKEN WITH A HILGER *E*1 QUARTZ SPECTROGRAPH

(*b*) AND (*c*) COMPARISON SPECTRA OF THE MERCURY ARC

Seven Raman lines with frequency shifts 375 (8), 417 (10), 432 (4), 450 (2), 578 (3), 642 (6) and 751 (7) cm.$^{-1}$ have been recorded in the alumina spectrum. The figures in brackets represent rough estimates of the relative intensities of the lines. Their positions as well as frequency shifts are marked in the accompanying spectrograms. A preliminary examination of the polarization characters indicated that the lines with frequency shifts 751 and 578 cm.$^{-1}$ should be assigned to the symmetric class and the rest to the degenerate class of vibrations. It is satisfactory to note that these results are in accord with the theoretical work of Bhagavantam and Venkatrayudu[4], who showed that the unit cell containing two Al_2O_3 groups has eighteen distinct frequencies of atomic vibration, of which two of the totally symmetric class and five of the doubly degenerate class should be active in the Raman effect.

The foregoing results are of interest in relation to the luminescence and absorption spectra of ruby which, as is well known, is crystalline alumina with chromic oxide impurity present as a colouring agent. The electronic transitions of the Cr^{+++} ion are responsible for the two intense lines at 6927 and 6942 A., as well as a few other fainter lines in the neighbourhood appearing at the same position in luminescence and absorption. Besides these, there is a host of bands appearing on both sides of the principal doublet which become sharper at low temperatures: they are then more intense on the longer wave-length side in luminescence and on the shorter wave-length side in absorption. The suggestion[1,2] that these may arise from the combination of the vibration frequencies of the alumina lattice with the electronic transitions of Cr^{+++} ions has been fully confirmed by the present investigation. In fact, nearly all the bands have been satisfactorily explained by taking account of the seven Raman frequencies as well as the lattice frequencies which are active in infra-red absorption and noticed by Coblentz[5], Strong[6] and Parodi[7]. The loading of the lattice by the chromium ions will give rise to a perturbation of the vibrational modes, and this would explain the fact that in fluorescence and absorption the lattice vibrations appear as diffuse bands and not as sharp lines.

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April 11.

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[1] Deutschbein, O., *Ann. d. Phys.*, **14**, 729 (1932).

[2] Mani, A., *Proc. Ind. Acad. Sci.*, A, **15**, 52 (1942).

[3] Mani, A., unpublished work.

[4] Bhagavantam, S., and Venkatrayudu, T., *Proc. Ind. Acad. Sci.*, A, **9**, 224 (1939).

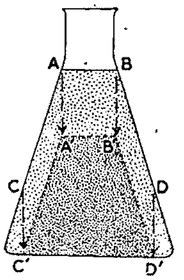
[5] Coblentz, *Investigations of Infra-red Spectra*, **5**, 17, 34 (1908).

[6] Strong, J., *Phys. Rev.*, **38**, 1818 (1931).

[7] Parodi, M., *C.R. Acad. Sci. Paris*, **205**, 906 (1937).

A Sedimentation Phenomenon

ONE of us (F. S.) was required some time ago to consider a proposed sedimentation apparatus for particle-size analysis, in which, for reasons beyond the scope of this note, the sedimentation vessel was to be a conical flask. Assuming the motion of each particle to be one of vertical descent, it was shown that an unstable condition would ensue. Suppose time has elapsed for particles of a specified size to fall from AB to $A'B'$. At this moment, no particle greater than the specified size will be above the surface $C'A'B'D'$, and the suspension within this region will have a higher specific gravity than the remainder. It was clear, therefore, that some flow of the suspension must occur and that the use of a conical flask would introduce an additional complication into the already difficult problem of particle size analysis.



Recently, one of us (R. J.) was shown a phenomenon which occurred after an aqueous suspension of potters' bone was shaken in a conical flask, and recognized it as connected with the above problem. When the flask was allowed to stand, normal settling commenced ; but after a few moments, alternating layers of clear and cloudy liquid appeared to be moving up the sides of the flask. This upward movement is evidently one phase of the readjustment which theoretical consideration requires, but it occurs rhythmically and not as a steady flow.

A similar effect has been observed with straight-sided vessels slightly tilted, suggesting that, when using such vessels, care in the vertical setting of the apparatus is of importance.

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Technique of the Analysis of Variance

The analysis of variance technique originally devised by Prof. R. A. Fisher for the interpretation of agricultural experiments concerned the case of equal frequencies in the sub-classes. Prof. Fisher himself extended his technique to the case of unequal frequencies[1], when only the effect of one single variable was under examination.

The more general case of unequal frequencies in the sub-classes and more than one variable was dealt with by Brandt[2] and Yates[3], the latter introducing constants fitted by the method of least squares. The analyses already mentioned are special cases of the results produced by this method.

The methods appropriate to the two simple cases can be developed by using orthogonal polynomials, but this is not possible in the general case. However, if the frequencies n_{ij}, say, are such that they can be separated into two factors $u_i v_j$, say, then orthogonal polynomials can again be constructed.

So far as I am aware, it has never been pointed out that this method is not equivalent to that of fitting constants, except in the two special cases mentioned earlier. For example, if two variables with two values each are considered, then the method of fitting constants leads to

$$(x_{11}+x_{12}-x_{21}-x_{22})^2\Big/\left(\frac{1}{n_{11}}+\frac{1}{n_{12}}+\frac{1}{n_{21}}+\frac{1}{n_{22}}\right),$$

and that of proportionate frequencies to

$$\left(\frac{n_{11}x_{11}+n_{12}x_{12}}{n_{11}+n_{12}}-\frac{n_{21}x_{21}+n_{22}x_{22}}{n_{21}+n_{22}}\right)^2\Big/\left(\frac{1}{n_{11}+n_{12}}+\frac{1}{n_{21}+n_{22}}\right),$$

for the measure of the effect of the first variable.

It appears that different definitions of effects and interactions are implied by the two methods. This is logically unsatisfactory, since the definition of an effect or of an interaction should not depend on whether the frequencies are noticed to be such that a change in the definition leads to easier computations. The method of fitting constants should therefore always be accepted as the only legitimate one.

A detailed analysis, showing also that the case of proportionate frequencies is unique in making the introduction of orthogonal polynomials possible, will appear elsewhere.

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[1] Fisher, R. A., "Statistical Methods for Research Workers", 4th ed. § 44 (1932).

[2] Brandt, A. E., *J. Amer. Stat. Assoc.* (1934).

[3] Yates, F., *J. Amer. Stat. Assoc.* (1934).

Significance of Multiple Innervation of Cutaneous Pain 'Spots' in Relation to the Quality of Pain Sensibility

If a sphygmomanometer cuff is inflated at a pressure above systolic blood pressure on a human limb, a progressive loss of cutaneous sensibility occurs peripheral to the cuff. The work of Lewis, Pickering and Rothschild[1] in this connexion has been repeated and amplified. These authors describe a regularly ascending 'centripetal paralysis', and attribute this mode of spread to an increasing susceptibility of individual nerve fibres to the effects of pressure as they are traced proximally from the periphery. We have been unable to confirm any such regular centripetal spread of sensory loss. It has been found that, in the territory of any given nerve, loss of sensibility commences in different sites, not only in different subjects, but also in repeated experiments in the same subject, and spreads irregularly rather than centripetally. Indeed, in several instances an almost regular centrifugal spread has been observed.

If the hypothesis of Lewis *et al.* is correct, and individual nerve fibres do indeed become more susceptible to pressure the more proximally they are traced, then sensory paralysis should appear more quickly the more proximally the compressing cuff is situated on the limb. It is certainly the case that sensory loss occurs more quickly when the cuff is on the upper arm than when it is on the forearm. The evidence available, however, indicates that, owing to anatomical factors, pressure is transmitted more effectively to the underlying nerves when the cuff is is any position on the upper arm than when it encircles the forearm. Thus the observed difference between upper arm compressions and forearm compressions can be explained on purely mechanical grounds[2]. Direct evidence that there is no such sensitivity 'gradient', as suggested by Lewis *et al.*, may be obtained by altering the position of the compressing cuff on the *upper arm*. It is then found that, whatever the position of the cuff, no difference can be observed in the time of onset of sensory paralysis.

Lewis *et al.* attribute the order of loss of the various sensory modalities in any skin area to a differing susceptibility of nerve fibres of large and small diameters. Our observations show that this hypothesis is inadequate to explain the results in detail. The manner in which any modality is lost appears to be fairly characteristic. Subjectively, there is first an alteration in the quality of the sensation, then prolongation of the response followed by delay in appreciation, and, finally, patchy loss of sensibility.

Our attention has been directed particularly to the alteration in the quality of pain sensibility which precedes the onset of analgesia. This altered quality appears to resemble very closely the unpleasant pain which can be elicited from certain cutaneous scars, and also from skin at the borders of areas which have either been recently denervated or are in the course of sensory recovery.

Sensory tests have been carried out in several such cases, and the areas of skin concerned have afterwards been examined histologically after vital staining with methylene blue. It was found that, in all cases where pain of an unpleasant quality could be aroused, the nerve nets and terminals subserving pain were invariably isolated from their neighbours, in contrast to the interweaving which normally obtains. In parenthesis, it may be remarked that such alterations in the peripheral pain network appear to be without effect on the threshold of pain sensibility, which was found to be correlated with abnormalities in the morphology of the endings. The lowest thresholds occurred when the subjacent pain fibres were surmounted by growth cones ending just beneath the basal layer of the epidermis.

Direct stimulation of pain fibres in a human digital nerve has shown conclusively that such fibres obey the 'all or none' law. It follows that no modification of the characteristics of the stimulus applied to a single pain fibre will give rise to any change in the quality of the sensation perceived. Taken in conjunction with the histological observations, this observation suggests that changes in quality are due to alteration of the number and peripheral pattern of the fibres involved in the conduction of impulses arising from a given stimulus. The alteration in quality of pain sensibility which occurs during compression of the arm is in strong support of the above hypothesis. The pain fibres do not all simultaneously cease to conduct, and there is, therefore, a period during which there is a progressive reduction in the number of active fibres proceeding from a given area, and also an alteration in the peripheral pattern of innervation. It is precisely during this period that alteration in the quality of pain sensibility occurs, and it is difficult to escape the conclusion that the subjective change is due to this process.

Further work along these lines is in progress, and it is hoped shortly to publish results in detail.

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[1] Lewis, T., Pickering, G. W., and Rothschild, P., *Heart*, **16**, 1 (1931).

[2] Weddell, G., and Sinclair, D. C., *J. Neurol., Neurosurg. and Psychiat.*, in the press.

British Folliculinidæ (Ciliata, Heterotricha)

DAS[1] has recently reported the occurrence at Cullercoats of two species of Folliculinidæ hitherto unrecorded for Great Britain, namely, *Folliculinopsis producta* Wright and *Folliculina simplex* Dons. He stated that only three other species have been recorded from Great Britain: *F. ampulla* Müller (Plymouth and Port Erin), *F. elegans* Clap and Lach. (Port Erin), and *Parafolliculina hirundo* Kent (Channel Islands).

To this list can be added[2] *Folliculina viridis* Wright, which, three years ago, during an intensive study of a rock pool in Langland Bay, Swansea, I found attached in some numbers to the fronds of *Corallina officinalis*. *F. viridis* is easily confused with *F. elegans*; but the former can be distinguished[3] by its smaller size and yellow-green colour. The overall length of my specimens (fully extended) never exceeded 400 μ.

Last year, while examining the fauna associated with *Porcellana platycheles* in Langland Bay, Swansea, I found the upper surface of the carapace and legs liberally encrusted with the (mostly) empty tubes of *Folliculina*. 310 tubes were counted on one crab, 128 of these being on the carapace. The dimensions and shape of the tubes, and absence of green colour in the living organisms, accord with the description given by Faure-Fremiet[3] for *F. elegans*.

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April 21.

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[1] Das, *Nature*, **159**, 502 (1947).

[2] Fowell, *Proc. Swansea Sci. and Field Nat. Soc.*, **2**, 192 (1944).

[3] Faure-Fremiet, *Biol. Bull.*, **70**, 353 (1936).

Erythrean Fishes on the Mediterranean Coast of Palestine

THE presence of fishes of Erythrean origin in the Levant has been observed by several authors[1-6]. It has also been stated that these fishes must have traversed the Suez Canal and settled more or less finally in the Mediterranean. As this process of immigration of fishes into an entirely distinct region is going on continually, it may be of interest to list briefly those species which have been collected by workers of the Hebrew University and have so far been identified.

Atherina pinguis Lac.[1]
Hemiramphus far (Forsk.)[4]
Cyprinodon dispar (Rüpp.)[5]
Therapon jarbua (Forsk.)
Apogon tæniatus C.V.
Holocentrum rubrum (Forsk.)
Mulloides auriflamma (Forsk.)
Teuthis sigana Gthr.[2,3,4,6]
Platycephalus sp.
Monacanthus setifer Benn.[2-4]

Four of the ten species listed here were mentioned by previous authors as captured in Palestinian or Syrian coastal waters. The remaining six have—so far as we are aware—not been recorded from Palestine or Syria as yet.

A discussion of the data published in this note will be given elsewhere.

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Jerusalem. April 25.

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[1] Norman, *Trans. Zool. Soc. London*, **22**, 3 (1927).

[2] Steinitz, W., *Pub. Staz. Zool. Napoli*, **8**, 3/4 (1927).

[3] Gruvel, "Les Etats de Syrie" (Paris, 1931).

[4] Hornell, Report on the Fisheries of Palestine (London, 1935).

[5] Mendelssohn, in the press.

[6] Kosswig, *C.R. Ann. Arch. Soc. Turque Sc. Phys. Nat.*, **10** (1942–43).

X-RAY CRYSTALLOGRAPHY

THE 1947 Conference of the X-ray Analysis Group of the Institute of Physics was held in the Royal Institution, London, on April 22 and 23. The first day was devoted to papers and discussion on the training of X-ray crystallographers for science and industry, and the second to descriptions of new techniques and results of X-ray analysis. The annual meeting of the Group was also held on the first day, and an evening lecture was given by Mr. H. P. Rooksby on "The Technique of X-ray Powder Photography" (see p. 7 of this issue).

It is impossible to give more in these notes than a very brief summary of the major contributions to the Conference. A fuller report will be published in the *Journal of Scientific Instruments*.

X-Ray Crystallographers in Industry

It became clear in the course of the two papers on this subject, and the discussion that followed, that there was general agreement on several interesting points. First, the demand for trained men still exceeds the supply, largely owing to a bottleneck in training; one way out of this difficulty, of which use has been made, is to send men already in industrial laboratories for short courses of training. This has the advantage that the workers are already acquainted with problems they will have to tackle, but the disadvantage that they cannot be spared for a length of time really adequate for training. Secondly, it was emphasized that a good X-ray analyst must have as broad a knowledge as possible of other sciences and techniques, in order to be able properly to assess the applications and limitations of his own technique.

Mr. D. A. Oliver suggested that a series of specialized monographs covering the whole theoretical and practical field would be useful to industrial X-ray crystallographers. He was of the opinion that, owing to general understaffing, industrial laboratories cannot usually offer much in the way of training apart from that in routine work, and that the present solution is that industry must assist in the training of research personnel by direct or indirect support of research in university departments.

Dr. L. Mullins gave details of a short course in X-ray crystallography given at Messrs. Kodak, Ltd., for industrial research personnel. Practical work includes the tackling of problems likely to arise in industry.

In the discussion, Sir Lawrence Bragg suggested that an appointments board in association with the X-ray Analysis Group might assist in the recruiting of X-ray crystallographers for industry. Mr. H. P. Rooksby was of the opinion that an industrial worker should be able to tackle fundamental problems, for which, however, a short course is not sufficient preparation. He also believed that those undergoing academic training would benefit by a period of apprenticeship in industry. Dr. W. A. Wooster agreed that work of a fundamental nature should be carried out in industry and suggested that research could usefully be divided into three types: (1) fundamental; (2) semi-fundamental; (3) technical. Dr. G. A. Jeffrey suggested that research organisations, when taking on university-trained men in order to start up an X-ray crystallography department, should take men from two or more university departments in order to ensure wide application of the technique.

Training of X-Ray Crystallographers in Polytechnics and Universities

The training of post-graduate chemistry students was discussed by Prof. E. G. Cox. This starts, in most universities, at a very elementary level, which is offset by a knowledge of the importance of the results of X-ray analysis to chemical problems. It is important to build on this by giving a man a research topic from the outset, which will encourage him both to acquire the necessary X-ray technique and also to widen his chemical horizons. Some formal instruction is considered necessary, covering crystal optics as well as X-ray analysis. Instruction in the latter is mainly concerned with structure analysis from single crystals, and here it is particularly important to find a suitable compromise between spending a great deal of time on learning to make and use equipment and do calculations, and becoming merely a machine-operator. To avoid the danger of becoming narrow-minded specialists, colloquia, visits to other workers, etc., are all important, but most important of all is the maintenance of the proper atmosphere in the laboratory.

The next speaker was Dr. H. M. Powell, who described the teaching in crystallography offered to students in chemistry at Oxford. It is realized that courses of two different types have to be provided: (*a*) for chemistry students generally, who need an outline knowledge of X-ray methods and their possibilities; and (*b*) for those intending to specialize in this work. Details of courses intended to meet this need were given, and stress was laid on the Oxford system of a graduate's fourth year of study, when a one-year research problem is tackled, sometimes leading on to further work.

Mr. F. Y. Poynton described how, in spite of all the difficulties of evening-class work, successful courses on the technical applications of X-ray diffraction had been run during the last few years, fitting into the general teaching of the Department of Applied Physics of the Northampton Polytechnic. The support of neighbouring industrial organisations had encouraged them to start recently a more detailed course for technicians beginning to use X-ray methods.

Dr. W. H. Taylor gave an account of the arrangements for teaching X-ray crystallography in Cambridge. He described the arrangements for Parts 1 and 2 of the Natural Sciences Tripos, and, leaving the Part 1 teaching to be described later by Dr. W. A. Wooster, went on to explain in detail the teaching for Part 2 students in chemistry, metallurgy and physics. Recognizing the two divisions of students mentioned by Dr. Powell, he showed how the content of each course is adapted to the needs and interests of each class of student and gave details of the practical work offered. He went on to describe the post-graduate work, explaining the advantages to the general outlook of students of the wide range of research, extra-mural, and administrative problems undertaken in the Cavendish Laboratory.

Dr. W. A. Wooster gave an account of the teaching of X-ray crystallography provided in the mineralogy course for Part 1 of the Natural Sciences Tripos at Cambridge. Emphasis was laid on the carefully prepared demonstrations and practical work and on the thoroughness of the teaching of the elementary ground-work, coupled with the Cambridge system of 'supervision' or private tuition. Dr. Wooster said that his Department would be pleased to try to help other people setting up similar courses by supplying photographs, etc., for demonstrations. He concluded by describing the content of an advanced course which he would like to see established.

Dr. R. C. Evans described the Cambridge Summer Schools in X-ray analysis which had been run for a fortnight each summer for the last four years. He gave details of the content of the course, explaining the importance attached to fundamental principles and the practical work undertaken by the students. In the subsequent discussion, Miss O. Weisz asked whether the material of the Cambridge Summer School could be published. Dr. Evans said that only photographs, etc., were yet available, and Dr. Lipson said that he hoped soon, in conjunction with Dr. Wooster and Dr. Henry, to publish a book based on the Summer Schools.

Further discussion brought out the advantages of both advanced and 'refresher' courses, though some speakers doubted whether research workers could spare the time required for these.

Dr. A. Taylor directed attention to the difficulties under which many technical colleges are operating, but Mr. N. Tunstall explained that the Ministry of Education is well aware of the position and is making considerable progress towards its improvement.

New Methods and Results of X-Ray Analysis

Investigations of the structure of the related minerals kaolinite, halloysite and fire-clays were described by Dr. G. W. Brindley. The study of kaolinite using high-resolution powder cameras showed that the unit cell is triclinic, not monoclinic as had been previously reported. The cell contains one unit of the silicate layer structure, and the way in which the layers are packed can be decided unambiguously. The powder patterns of halloysite and meta-halloysite show bands as well as sharp lines, which indicate almost complete disorder as regards the orientation of the layers. Heat-treated halloysite loses water and the layers collapse to form meta-halloysite; in the latter the layer spacing is still greater than in kaolinite, indicating that some water may still be trapped between layers. The state of crystallization of the kaolin mineral in fire-clays is intermediate between that of kaolinite and halloysite.

Mr. C. W. Bunn discussed investigations of the structurally similar (6, 6) and (6, 10) nylons or polyamides. Squeezing the fibres causes the orientations of the crystals to simulate twinning, and from these specimens it is possible to determine the triclinic unit cell, and work out the atomic positions by trial and error. It has been found that the chain molecules, which have a planar zigzag configuration, are linked by hydrogen bonds to form sheets. The sheets can pack together in two ways to form either α-crystals which have a one-molecule triclinic cell, or β-crystals which have a two-molecule triclinic cell. However, streaks which appear on most fibre photographs indicate a certain degree of random changeover from α- to β-type of packing.

Dr. W. Cochran, in his paper on sucrose, pointed out that it is one of the few comparatively simple organic compounds for which the accepted stereochemical formula has never been confirmed by chemical synthesis. For this reason X-ray analysis of its structure has been attempted, but so far with no success. However, the structures of isomorphous addition compounds with sodium bromide and chloride have been completely solved by two-dimensional Fourier methods, and results indicate that the sucrose molecule can be described as 1-α-glucopyranose-2-β-fructofuranose. The accuracy of the analysis was judged by the agreement between observed and calculated electron density distributions.

Mrs. Hodgkin gave a general account of the investigation of the structure of penicillin, and paid tribute to all those who had assisted in this work. Before X-ray work started, the chemists had proposed several possible formulæ, including (1) 'oxazolone', (2) 'β-lactam', (3) 'tricyclic'. X-ray analysis began on the sodium benzyl salt, but no progress was made with this. It was, however, possible to find the atomic positions of the alkali atoms and also the sulphur atom in the potassium and rubidium salts. Meanwhile, Mr. Bunn tried the 'fly's-eye' technique on an 'oxazolone' structure, at that time favoured by chemists, for the sodium salt, and succeeded in getting a *b* electron-density projection which was partially correct. The *b* projections for all three salts were re-examined and a related set of peaks found in all of them which was assumed to represent the molecule. After that the work was comparatively straightforward, and a three-dimensional synthesis proved the molecule to have the 'β-lactam' structure. Mr. C. W. Bunn described how he had used the 'fly's-eye' technique in conjunction with Bragg–Lipson structure factor graphs, and also a new method arising out of the latter for refining atomic positions.

In the course of the discussion which followed, Dr. H. Lipson said that he believed that comparison of observed and calculated intensities is the only satisfactory method of checking the accuracy of a structure, and Prof. E. G. Cox thought that the factor

$$\frac{\Sigma(F_{\text{obs}}-F_{\text{calc}})}{\Sigma F_{\text{obs}}}$$

provides the most satisfactory check now available; although, as Mrs. Hodgkin pointed out, it is not completely reliable.

New Industrial Techniques and Results

The afternoon session was opened by Dr. J. Bailey, who gave examples of the application of X-ray crystallographic equipment to the solution of technical difficulties in metallurgical production.

Dr. T. Ll. Richards illustrated some metallurgical applications of the stereographic projection, including an analysis of the mechanism of recrystallization in cold-rolled 70/30 brass.

Dr. H. D. Megaw, giving the first of several papers on ferro-electric compounds, described these as having an abnormally high permittivity, analogous to the high permeability of ferromagnetic materials. Of the perovskite-type group of compounds, barium titanate alone shows a distortion of the ideal cubic structure that is not compatible with Goldschmidt's principles. Barium titanate shows a reversible second-order transition at c. 120° C. to the ideal cubic form, and there are indications that there may be another transition at a low temperature. The transition from the cubic form is accompanied by characteristic multiple twinning.

Mr. M. J. Harwood described further work on the temperature variations of the barium titanate structure. He directed attention to the co-existence of both cubic and tetragonal phases in the region 120–125° C. Showing curves for the variation of cell dimensions of each phase with temperature, he explained the details by assuming that the lattice of the new phase is at first built on that of the old, and that the stresses thus set up increase until they are relieved by the formation of the new phase as a separate structure.

Mr. H. F. Kay described some optical work on crystals of barium titanate which he had prepared from a melt. He had observed domains which were truly single-crystal, and had followed the changes occurring at the high-temperature transition and also at and below 0° C.

Dr. L. A. Thomas described how Wooster's method of removing the Dauphiné (or 'electrical') twinning of quartz by applied heat and stress, although in general effective, had in some cases proved unsuccessful. Instead of the twin boundaries being removed, the twinned areas may show regions of persistence which can be correlated to some extent with the darkening response to irradiation with X-rays.

Mr. H. S. Peiser discussed the determination of the amorphous : crystalline ratio in polythenes. Working to a standardized procedure, it is possible, by microphotometric intensity measurements of the amorphous and crystalline X-ray patterns, to compare the ratios for different samples to an accuracy of ± 3 per cent.

Dr. C. J. Brown described some of the organic structure determinations carried out in his laboratory. Anthranilic acid, sodium naphthionate, acetanilide, and the new synthetic fibre 'terylene', were among the structures described.

Dr. A. F. Wells directed attention to the increasing tendency of chemists to use the results of X-ray crystallography in an insufficiently critical manner, and pointed out the responsibility which this places on the X-ray worker.

Dr. W. J. Wrazej gave some results on the structure of retained austenite in plain carbon steels, which indicated that it should be regarded as a face-centred tetragonally distorted structure rather than face-centred cubic.

In the discussion which followed these papers, many points in connexion with the barium titanate structure were raised, it being evident that the mechanism of transition from the tetragonal to the cubic phase is still very imperfectly understood.

Annual General Meeting of the X-Ray Analysis Group

In his report as chairman of the X-ray Analysis Group of the Institute of Physics, Sir Lawrence Bragg reviewed the previous very successful year and described the steadily widening activities of the Group. Sir Lawrence now retires from the office of chairman, and Mr. D. A. Oliver (director of research, B.S.A. Group of Companies) succeeds him. It was agreed to request the Board of the Institute of Physics to approve the creation of the office of vice-chairman, and Dr. W. H. Taylor (Crystallographic Laboratory, Cavendish Laboratory, Cambridge) was elected. Mr. J. N. Kellar (Crystallographic Laboratory, Cavendish Laboratory, Cambridge) was elected honorary secretary in succession to Dr. F. A. Bannister. Dr. H. Lipson, Mr. H. P. Rooksby and Dr. A. J. C. Wilson retired from the Committee, and Dr. R. C. Evans, Dr. T. Ll. Richards, Prof. J. M. Robertson and Prof. W. T. Astbury were elected, the last subject to the Board of the Institute agreeing to augment the membership of the Committee by one.

The business of the meeting was followed by reports, given by Dr. W. H. Taylor, Dr. R. C. Evans and Dr. F. A. Bannister, on the work of the equipment panels set up in the latter part of 1946. The Fourier Service Panel has concluded that the demand for a central calculating service is not large enough to justify setting up a special organisation, and those requiring assistance can apply direct to Dr. L. J. Comrie's organisation. New and improved Beevers–Lipson strips are being prepared. The X-ray Tube Panel, having made a general inquiry of users in Great Britain, has prepared a user specification for an 'ideal' demountable hot-cathode X-ray tube, but is taking no action in this matter beyond passing certain recommendations for improvement to the Raymax and Hilger sets to the appropriate firms. Specifications for moving anode and sealed-off tubes are being prepared. The Single Crystal Camera Panel is proceeding with a specification for a Weissenberg-type camera. The Powder Camera Panel is proceeding to design and prepare prototypes of a high-temperature camera, with the help of Mr. Oliver's organisation. Dr. W. H. Taylor announced that it is hoped to receive, through the Ministry of Supply, a number of sealed-off Philips tubes from Germany to fill the gap before tubes can be produced in Britain. Panels to deal with crystal structure models and miscellaneous equipment have also been set up.

A. M. B. Douglas
J. N. Kellar

PRODUCTION OF ANTIBIOTICS BY *FUSARIA*

By A. H. COOK, S. F. COX, T. H. FARMER
AND
M. S. LACEY
Imperial College of Science and Technology, London

Earlier communications[1,2,3] described the production of an antibiotic pigment, javanicin, by *Fusarium javanicum*, and other *Fusaria* were also observed[1] to give rise to antibiotic metabolism solutions. So far, the examination of twenty-two *Fusarium* strains has revealed a frequent property of this kind; for convenience the moulds may be divided into groups according to the kind of activity exhibited by the crude culture fluids.

Group I, equally active against *Mycobacterium phlei* and *Staphylococcus aureus*: *F. javanicum*, *F.*6, *F.*64 (*F* numbers refer to strains which are as yet unidentified).

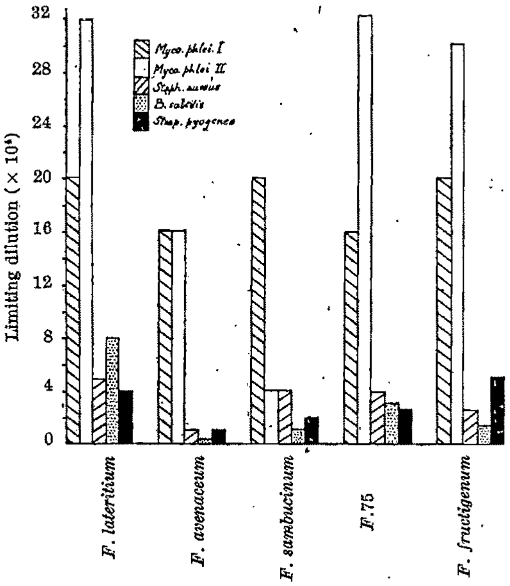
Group II, more active against *Myco. phlei* than against *Staph. aureus*: *F. lateritium*, *F. avenaceum*, *F. sambucinum*, *F. dianthii*, *F. fructigenum*, *F.*63, *F.*75 (probably a further strain of *F. lateritium*).

Group III, active against *Myco. phlei*, inactive against *Staph. aureus*: *F. culmorum* (Str. 61), *F.*72, *F.*91, *F.*101.

Group IV, inactive against both *Myco. phlei* and *Staph. aureus*: *F. oxysporum cubense*, *F. culmorum* (2nd strain), *F. cœruleum*, *F.*8, *F.*10, *F.*26, *F.*73, *F.*88.

Clearly this classification may depend on the cultural conditions employed, and it would in any event be less significant if the varying activities were merely due to varying proportions of two antibiotics or classes of antibiotics. Closer examination, however, has afforded chemical evidence which suggests that this division may reflect a more fundamental biochemical grouping.

The antibiotics produced by *F. lateritium*, *F. avenaceum*, *F. fructigenum*, *F. sambucinum* and *F.*75 (probably also a strain of *F. lateritium*) (Group II above) under selected conditions have now all been isolated in pure crystalline state. Excepting the



product of *F. fructigenum*, it is believed that under the culture conditions employed these new compounds represent the whole of the antibacterial activity present in the crude metabolism solutions. Naming them conventionally according to the species from which they are derived (that from *F*.75 being provisionally termed lateritiin-II) these compounds are quite distinct, the melting point of a mixture of any two being depressed: Lateritiin-I, $C_{26}H_{46}O_7N_2$, m.p. 121–122°; lateritiin-II, $C_{26}H_{46}O_7N_2$, m.p. 125°; avenacein, $C_{25}H_{44}O_7N_2$, m.p. 139°; fructigenin, $C_{26}H_{44-46}O_7N_2$, m.p. 129°; sambucinin, $C_{24}H_{42}O_7N_2$, m.p. 85–86°. These formulæ are regarded as subject to some revision of detail, though each is based on repeated concordant analyses. The compounds are also distinct in their antibacterial properties, as appears from the differing 'bacterial spectra' in the accompanying graph.

On the other hand, the compounds are so similar in chemical behaviour as to leave no doubt that they owe their biological activity to similar structural features. They are colourless, optically active, neutral, and sparingly soluble in water, but very soluble in organic solutions including light petroleum. All are stable to mineral acids under ordinary conditions, and to heat; indeed, lateritiin-I could be distilled *in vacuo* without chemical change occurring. However, all are very unstable to alkali, so that all antibacterial activity is irreversibly lost in solution at *p*H = 10–11 at room temperature after 18 hours. During this inactivation approximately two acid groupings per molecule are produced but disappear again, possibly by lactonization, when attempts are made to isolate the primary inactivation product. The group of compounds is otherwise notable for its lack of easily recognizable structural features. Thus avenacein contains no acidic, basic, carbonyl or alkoxy groups, nor any active hydrogen atoms detectable by the usual means. It does, however, contain two N-methyl and four C-methyl groups. When the compounds are heated with concentrated hydrochloric or hydrobromic acid at 120°, they are degraded to optically active crystalline bases which contain all the nitrogen present in the antibiotics. In addition, each of the antibiotics gives rise to the same crystalline acid, $C_5H_{10}O_3$; in the case of lateritiin-I the yield approaches that corresponding to the formation of two molecules of acid. The latter has been completely identified as the optically active α-hydroxy*iso*valeric acid corresponding to *d*(-)valine. To the best of our knowledge this acid has not previously been obtained directly from any natural source. It is interesting to note its correspondence with the amino-acid and particularly its retention of optical activity, the configuration being the 'unnatural' one.

Attention was specially directed to these antibiotics because of their action against *Myco. phlei* and possibly, therefore, against *Myco. tuberculosis*. Tests with lateritiin-I against three strains of tubercle demonstrated *in vitro* inhibitions at limiting dilutions of 1 : 160,000–1 : 640,000, indicating a high activity. Mouse experiments pointed to relatively low toxicity, at least by intraperitoneal administration. We are indebted to Drs. P. D'Arcy Hart and R. E. Glover (National Institute for Medical Research) for these results, but any therapeutic possibilities remain largely to be explored.

It has been noted that these *Fusarium* antibiotics are best produced when the mould is in a somewhat metabolically degenerate state. Perhaps such antibiotics are normal but mostly transient metabolic products, which only accumulate in sufficient quantities to permit of their recognition and isolation under abnormal culture conditions. It may perhaps be further envisaged that more deliberate induction of a moderately degenerate state may afford a degree of control over antibiotic production. Finally, it is worth noting that the above compounds appear to be products of an arrested metabolism exerting an antibiotic action on other presumably similar though obviously distinct metabolisms. The fact appears to offer perhaps profitable speculation on the mechanism of such manifestations of interference.

Full details of the above work will be published elsewhere. We are indebted to the Medical Research Council for assistance, and to Sir Ian Heilbron for his interest and encouragement.

[1] Cook, A. H., and Lacey, M. S., *Brit. J. Exp. Path.*, **26**, 404 (1945).

[2] Arnstein, H. R. V., Cook, A. H., and Lacey, M. S., *Nature*, **157**, 333 (1946).

[3] Arnstein, H. R. V., and Cook, A. H., *J. Chem. Soc.*, in the press.

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

ANNUAL REPORT

THE annual report of the National Institute of Economic and Social Research for 1945–46 welcomes the recommendations of the Clapham Committee and particularly the declaration in that Report as to the national importance of the realistic studies to which the Institute has consistently devoted itself. Commenting on the new approach to economic problems illustrated by the elaboration of national income studies, the Institute's report points out that in Britain, in spite of sharp disagreement about particular methods and policies, there is a considerable measure of agreement about the ultimate goals of economic and social policy and the intellectual terms in which these problems may most profitably be set out, discussed and investigated. Moreover, the Institute has been able, through its Occasional Paper No. X, "A System of National Book-keeping:

Illustrated by the Experience of the Netherlands Economy", by Prof. J. B. D. Derkson, to make available to English readers some of the basic researches behind developments in economic planning in Holland, and it has also provided a meeting-place for the discussion of technical aspects of such problems between official representatives from Norway and Sweden and those engaged in similar work in Britain.

The immense tasks which face the advisers of Government call for a wealth of factual, quantitative information about the British economy and its development in the recent past which cannot be supplied entirely from official sources, and the contribution of the Institute in this field is of increasing importance. Of particular significance in this connexion, through its bearing on the structure and productivity of the national economy, is the inquiry on the "National Expenditure, Output and Income, 1920–38", which continued to be directed by Mr. Richard Stone. A first volume containing the results of the investigation into consumers' expenditure is already in the hands of the printers: as is a report on "Productivity, Prices and Distribution in Selected British Industries". A second report from the same investigation, "International Comparisons of Productivity in British and American Manufacturing Industry", is now being finally prepared for publication, while during the year work was started on the distribution inquiry with the aim at the first stage of building up a factual picture of the channels by which consumer goods passed from the manufacturer to the public in the immediate pre-war period. The second stage of the inquiry is concerned with the more difficult problem of the functions, stock turn, and cost and profit experience of different types of wholesaler and retailer. Late in 1945 a building inquiry was commenced, under Mr. I. Bowen, covering the structure and efficiency of the building industry, housing demand and the building cycle, and economic problems arising from new building techniques. Main attention is being given to the first topic, and it is hoped that a report on this part of the programme will be completed during 1947.

The work on capital formation and public authority expenditure has continued, attention so far having been concentrated on the current and capital expenditure of local authorities. The inquiry into disease mortality and its changing distribution has issued in a draft report "The Social Geography of Mortality in England and Wales, 1911–38"; but Dr. Kuczynski's study of post-war population problems has been suspended while the Royal Commission on Population is in session. The inquiry into advertising has been completed, and a report on "Statistics of Advertising" is to be published later. Miss P. M. Deane completed her Occasional Paper, "The Measurement of Colonial National Incomes: an Experiment", before taking up her field experiments as a Colonial research fellow in Africa. A joint exploratory committee with representatives of the Institute of Chartered Accountants has considered the field of work in which accountants and economists have a common interest, and it is hoped to publish later an agreed statement of its findings. Senior research fellowships were awarded during the year, under the scheme described in last year's report, to Mr. E. J. M. Buckatzsch for an inquiry into "Factors Affecting Income per Head in Towns and Areas in England and Wales, 1929–1939", to Miss K. Liepmann, for an inquiry into "The Extent and Composition of Labour Markets in Selected Areas in the South West", and Mr. H. G. Schenk's part-time fellowship has been extended to enable him to complete his inquiry into "European Romanticism and the Social Revolution, 1790–1830". The Register of Research in the Social Sciences for 1940 is being distributed as a confidential document. New Institute publications during the year are listed in the report.

SALMON MIGRATION AT SEA

THE Buckland Foundation Lecture was given by J. W. Menzies at the University of Liverpool, on May 28, Prof. J. H. Orton presiding. Taking for his subject "The Migrations of Salmon in the Sea", Mr. Menzies summarized the information learned from the experiments of marking salmon in Scottish, Norwegian, Baltic, and Canadian haunts, and suggested that European and Canadian salmon have a common feeding ground in the North Atlantic near Iceland, where a new marking station will probably be opened under international co-operation in a few years time. The only area where *Salmo salar* has been traced from the river of origin to its feeding ground in the sea and then back to the river as adult fish is the Baltic, where Swedish marking experiments showed that smolts left the northern Swedish and Finnish rivers in spring when only 5 in. long and reached the southern Baltic, 600–800 miles away, in October and November, when they weighed just over a pound after feeding; but they did not show evidence of passing out of this belt into the North Sea. Salmon apparently do not feed in the North Sea, or The Minch of western Scotland, or they would have been caught more often in the herring nets. The Swedish salmon feed in the southern Baltic for possibly up to two or three years before returning to their native rivers.

Salmon marked in the Gulf of St. Lawrence, and off the shores of Scotland and Norway, have shown two types of movements. In one they have been recovered after they have nearly completed their journey home again, when they remain off the river until a flood induces them to ascend. They cease feeding once they reach the coast, and if a drought keeps them there some weeks or months, they lose weight, a 15-lb. fish losing 2–3 lb. in a little more than two months while waiting to ascend the river; a 15-lb. fish lost 4 lb. in 67 days; a 12-lb. fish lost 2 lb. in two months. Only five marked fish were recovered more than ten miles from Thurso Bay, and marking showed a similar restricted movement in the inner Moray Firth; only six out of more than 400 strayed outside the outer limits of the Firth, and there were similar results from Canada and Norway.

Other salmon, particularly those marked off south-west Newfoundland, western Scotland and western Norway, made long journeys to the place of capture, the record being a St. Lawrence fish caught as a clean fish in sea nets 2,000 miles away up the Labrador coast, while from near the north of Norway an easterly migration has been traced to the River Petchora, the easterly limit in the distribution of *Salmo salar*. In both Canada and Scotland these long journeys have often been four or six hundred miles, and on the Norwegian coast 1,600 miles to the White Sea. Marked salmon have travelled between Scotland and Norway, but not across the Atlantic, so far as recoveries show; but all these fish seem to be going back to the river from which they came as smolts.

Marking not only indicates the length of migration, but also the speed, and the longer the migration the faster appears to be the speed, especially with Norwegian records, one of which was recovered 680 miles away in a little more than ten days, a speed of 62 miles per day. Adult salmon in the sea travel at a minimum rate of between ten and twenty-five miles a day.

Mr. Menzies suggested that the cause of the very poor salmon season of 1945 in Britain probably lay in feeding conditions at sea, not in fresh-water rivers, because in Iceland, Norway and Canada this was also a bad season. When swimming near the coast, salmon travel within 7 ft. of the surface; but although herring and sand-eels have been found in them, very little is known of their diet in the sea, and those caught near the shore were almost invariably empty.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, July 7—Wednesday, July 9

University of Bristol (at the H. H. Wills Physical Laboratory, Royal Fort, Bristol), at 9.30 a.m. and 2.45 p.m. each day.—Conference on "The Strength of Solids".

Monday, July 7—Thursday, July 10

Royal Society, Gassiot Sub-Committee B (at Burlington House, Piccadilly, London, W.1).—Conference on the "Emission Spectra of the Night Sky and Auroræ".

Monday, July 7

At 11 a.m.—Prof. S. Chapman, F.R.S.: Opening Address.

Monday, July 7—Saturday, July 12

Chemical Society, Society of Chemical Industry and Royal Institute of Chemistry, Edinburgh and East of Scotland Sections (at The University, St. Andrews).—Symposium on "Coal, Petroleum and their Newer Derivatives".

Tuesday, July 8

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. D. Rittenberg (Columbia University): "The Application of the Isotope Technique to some Biochemical Problems".*

Wednesday, July 9—Saturday, July 12

Society for Applied Bacteriology (at Reading).—Annual General Meeting and Paper Reading Conference.

Wednesday, July 9

At 8 p.m. (at St. Andrews Hall).—Annual General Meeting.

Thursday, July 10

At 10 a.m. (in the Zoology Lecture Theatre).—Symposium on "Water Bacteriology"; at 2.15 p.m.—Paper Reading Conference.

Friday, July 11

At 10 a.m.—Paper Reading Conference.

Thursday, July 10—Saturday, July 12

Institute of Physics, Manchester and District Branch (in the Physics Department, The University, Manchester).—Conference on "Applications of Radioactive Tracer Elements in Physics Research and Industry".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Textile Technology, and a Lecturer in Mathematics—The Registrar, College of Technology and Commerce, The Newarke, Leicester (July 12).

Senior Assistant (with a good Honours degree) in the Department of Chemistry, a Lecturer in Pharmacy, a Lecturer (with a good Honours degree or its equivalent) in Mathematics, Senior Assistants (3) in (*a*) Design Section, (*b*) Production Engineering Section, (*c*) for Research and Experimental work, and Lecturers (2) for (*a*) Design Section, (*b*) Production Engineering Section, in the Department of Mechanical Engineering, Lecturers (2) in Electrical Engineering up to Higher National Certificate standard, and Lecturers (2) in (*a*) Carpentry and Joinery, (*b*) Plumbing and Sanitary Engineering, in the Department of Building and Structural Engineering—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (July 12).

Lecturer in Zoology and Chemistry—The Registrar, Merchant Venturers' Technical College, Bristol (July 12).

Lecturer in Physics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (July 12).

Lecturer in Chemistry—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (July 14).

Lecturer in Mathematics in the United College—The Secretary, The University, St. Andrews (July 15).

Lecturer in Geology (Petrology and Mineralogy) in University College, Dundee—The Secretary, The University, St. Andrews (July 15).

Lecturer in Zoology to take charge of the Gatty Marine Laboratory—The Secretary, The University, St. Andrews (July 15).

Lecturer in Physics, and a Lecturer in Civil and Mechanical Engineering—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (July 19).

Lecturer, and an Assistant Lecturer, in Physics—The Secretary, King's College, Strand, London, W.C.2 (July 21).

Adviser in Agricultural Economics, a Senior Agricultural Economist, and an Assistant Agricultural Economist—The Registrar, The University, Manchester 13 (July 26).

Lecturer in the Technical Department, for City and Guilds Telecommunications up to Grade 5—The Technical Officer, University College, Southampton (July 26).

Lecturer (Grade II) or Assistant Lecturer (Grade III) in Physics—The Registrar, University College, Southampton (July 26).

Lecturer in Philosophy in the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 30).

Dairy Officer in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (July 31).

Statistician in the office of the Town Clerk—The Town Clerk, Town Clerk's Office, Room 30B, Council House, Birmingham 1, endorsed 'Central Statistical Officer' (July 31).

Zoologists (4) with special experience of taxonomic work on (*a*) mammals, (*b*) fishes, (*c*) arachnida, and (*d*) mollusca, and Entomologists (4) with special experience of taxonomic work, at the British Museum (Natural History)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1936 (July 31).

University Lecturer in Physics—The Secretary of the Appointments Committee, Faculty of Physics and Chemistry, Chemical Laboratory, Pembroke Street, Cambridge (July 31).

Lecturer in Pathology—The Registrar, The University, Sheffield (July 31).

Director of Research for the development of Rheumatism Treatment and Research, and a Research Fellow in the Surgery of Rheumatism—The Registrar, The University, Leeds (July 31).

Soil Biochemist, a Physical Chemist with experience in a colloid laboratory or used to X-ray technique, a Physical Chemist with experience in spectroscopic or polarographic techniques, a Soil Chemist with general soil experience, and a Soil Chemist with some training in botany as well as chemical experience, in the Soil Bureau, Wellington—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (August 1).

Junior Physico-chemist for bacteriological and virus research work—The Secretary, Inoculation Department, St. Mary's Hospital, Paddington, London, W.2 (August 1).

Assistant Lecturer in the Department of Embryology—The Secretary, University College London, Gower Street, London, W.C.1 (August 1).

Senior Research Officers (2), Research Officers (12), Assistant Research Officers (6), and Research Assistants (7), in the Ministry of Town and Country Planning—The Secretary, Ministry of Town and Country Planning, 32 St. James's Square, London, S.W.1 (August 15).

Statistician—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

Game Ranger (with a science degree, preferably in zoology) in Tanganyika Territory—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

Research Student in Soil Science—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

Librarian—The Assistant Secretary, Royal Anthropological Institute, 21 Bedford Square, London, W.C.1.

Lecturer (Grade III) in the Department of Chemistry—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

Research Chemist—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx.

Director of Research—The Chairman, British Welding Research Association, 29 Park Crescent, London, W.1, endorsed 'Director'.

Research Engineer for research on machinery used in the clay industry—The Director of Research, British Pottery Research Association, Queens Road, Penkhull, Stoke-on-Trent.

Technician for Biochemical Department—The Bursar, The University, Sheffield 10.

Senior Assistant, and a Lecturer, in the Department of Electrical Engineering—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18.

Lecturer in Telecommunications, with specialist knowledge in Radio Engineering—The Principal, Wimbledon Technical College, Gladstone Road, London, S.W.19.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Gazetteer of Great Britain: giving the Position of Towns and Important Villages shown on Ordnance Survey Maps in terms of the National Grid. Pp. 54. (Chessington, Surrey: Ordnance Survey, 1946.) 5*s*. [231

Alkali &c. Works Regulation Act, 1906, and Alkali &c. Works Orders 1928–1939: Eighty-second Annual Report on Alkali &c. Works. By the Chief Inspectors. Proceedings during the Years 1939–1945 inclusive. Pp. 48. (London: H.M. Stationery Office, 1947.) 1*s*. net. [291

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TRAINING FOR MANAGEMENT

SINCE the Urwick Committee was appointed in October 1945, "To advise the Minister of Education on educational facilities required for management in industry and commerce, with particular reference to the steps to be taken in regard to the organisation of studies, bearing in mind the various requirements of professional organisations and the need for their co-ordination", the importance of efficient management has been repeatedly stressed in relation to the productive effort of Great Britain, and the Government has already accepted the recommendation of the Baillieu Committee for the establishment of a British Institute of Management. The eighth International Conference on Management, at which Great Britain was represented, has recently been held in Stockholm. The Urwick Committee reported in August 1946, but after a meeting with representatives of the professional bodies concerned with the part-time study of management in technical and commercial colleges, certain amendments to the report were made by the Committee. The amended report now published* is not only approved by the Minister of Education, but also the institutions and associations represented at the meeting have agreed to do all in their power to implement its recommendations.

Such circumstances alone would give practical interest to the report, which not only contains a number of sensible recommendations on training for management, but also indicates some aspects of the problem which require further investigation. The Committee takes a wide view of management, which in this context it understands as all those activities involving responsibility for the work of others. It is pointed out, however, at the outset that no matter how good special courses of study at technical or commercial colleges may be, theoretical study alone cannot make a manager.

On this basis the Committee attempts to estimate the number of persons engaged in managerial functions at the present time. It has not been able to arrive at an accurate estimate as there are no figures later than the 1931 Census to serve as a basis ; but starting from these figures, and allowing for the considerable changes that have occurred since, the Committee computes that between 400,000 and 450,000 persons in Great Britain are so engaged at the present time. This is a considerable total, and although it is to be hoped that, as recommended by the Hankey Committee, the Higher Appointments Department of the Ministry of Labour and National Service and, as here suggested, the British Institute of Management, will obtain more accurate information in due course, the estimate can be used to arrive at an even more important figure from the point of view of training facilities—the approximate number of recruits each year.

Assuming that the working life of individuals discharging managerial functions is thirty-five years, the Urwick Committee estimates the annual intake as some 12,000 ; this is admittedly a rough guess, but one which indicates the magnitude of the problem. There are, of course, complications such as the wide variation in the ages at which individuals take up positions which are classed as managerial under the definition already given—the scientific worker himself provides a pertinent example. Dr. Vannevar Bush, in his recent report as president of the Carnegie Institution of Washington, referred to the duty of men of science to participate increasingly in the task of government by manning the boards and committees which are necessary to-day to provide scientific and technical advice. There are many other more specific administrative and managerial responsibilities which trained scientific men must accept if the business of government and industry alike is to be conducted efficiently; and yet, as the Percy Committee noted, not only is the highly trained technician often indisposed to accept such responsibility, but also he is often ignorant of the principles of industrial organisation and management. Admittedly much in this field can only be learnt from experience, but there is a body of knowledge in existence, awareness of which may greatly facilitate the process of learning.

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* Ministry of Education. Education for Management : Management Subjects in Technical and Commercial Colleges. Report of a Special Committee appointed by the Minister of Education. Pp. 32. (London : H.M. Stationery Office, 1947.) 6*d*. net.

There is, of course, nothing new in the suggestion that management should be the subject of theoretical study; although management is still often regarded primarily as a matter of common sense and experience, and frequently knowledge of a particular branch of business is still the sole criterion of competence. In the last thirty years, since the work of F. W. Taylor and Henri Fayol became better known, a large body of knowledge bearing upon what Fayol described as the six main activities of management—forecasting, planning, organising, commanding, co-ordinating and controlling—has been built up, irrespective of the field of industry to which they are applied. Most people would probably agree with the Percy Committee that ignorance of the main findings of studies in these fields is a real handicap to men who would otherwise be highly qualified for administrative work. It is less certain that it is generally recognized, as the Urwick Report claims, that there is general ability to manage which can be made the subject of a recognized 'discipline' based on objective research: the Percy Committee, for example, appears to reserve its opinion on the subject and is at least dubious.

Examining the special character of this body of knowledge, the Urwick Committee points out that it is distinct from any detailed understanding either of the processes of the particular industry or of the various services and skills which are themselves indispensable tools for the conduct and regulation of a complex organisation. The Committee claims that such knowledge should enable its possessor to determine the immediate and the long-term objectives of the whole, or of any part of the undertaking, to judge readily the significance and the comparative importance of the varied advice which he receives, and to appreciate the contribution which the expert, whether as an individual or in combination with others, is able to make. It should also teach him how to use each contribution effectively, and to integrate these several abilities so as to ensure the most appropriate action. The technique of attaching to each factor its due weight and of making the necessary synthesis can in part be taught, even if its exercise is a matter of judgment in which personal capacity and experience are the essential factors.

Whether or not we admit the claim of management studies to be a scientific 'discipline', there are certain foundations upon which alone management can be taught. The Urwick Committee distinguishes these as of three types: an adequate standard of general education; knowledge of certain 'background' subjects which provide a basis for the study of management in any particular field; and certain 'tool' subjects, such as accounting, statistical method, production methods, work analysis and incentives of which the manager should possess a sufficient appreciation of their principles, processes and application to be able to direct skilled assistance effectively. The varied channels through which the individual approaches managerial responsibilities make it difficult, if not impossible, to provide a course of study which insists on any common background. Nor is it even a disadvantage to the nation that the pattern of recruitment, while changing considerably in the last twenty years, should be varied; and the Urwick Committee is right in insisting that no matter how comprehensive the national system of education, opportunities to obtain the higher posts in business should continue to be open to those whose training has been predominantly in the school of experience. The capacity for initiative and leadership is not solely, nor even mainly, a matter of intellectual quality, and no system of tests or competitive examinations, however careful and objective, is a fully satisfactory determinant of the power to discharge major responsibilities. It may, of course, be asked whether this could be determined by any system.

While, however, the Urwick Committee believes that managers in industry and commerce will continue to be recruited from four main groups, one of which would consist of those with initial scientific or technical qualifications (such as engineers, chemists or accountants), who find themselves increasingly occupied with managerial functions, it strongly deprecates the multiplicity of syllabuses both within the broad management field and within the fields of professional institutions conducting examinations including subsidiary management features. The major part of the report is indeed concerned with suggestions for the assimilation and development of courses, so as to relieve the embarrassment of education authorities and secure the most effective use of the limited supply of trained teachers.

The Urwick Committee recommends first that the professional institutions should accept the obligation to include in their syllabuses as large a common management content as possible, and confine specialized demands in this field to the essential minimum. Courses leading to qualifications in management should be limited to two stages. For the first, or intermediate, of these courses, all management professional institutions should adopt a common curriculum, and technical professional institutions should adapt any management requirements to this common curriculum, which would comprise an introduction to management, 'background' subjects and 'tool' subjects. For the second or final course, two types are suggested, intended for those who wish to qualify in some specialized field, or in general management, respectively. For the former the curriculum should be prescribed largely by the appropriate management professional institution; but for the latter the curriculum should be prescribed by the appropriate national authority. Suggested syllabuses for both intermediate and final courses are appended to the report, and it is recommended that both courses should lead to a qualifying examination. The final examination in specialized management should not be taken before the age of twenty-five, or in general management before the age of twenty-eight.

The Committee contemplates that such courses will be taken in the main as part-time studies. Although it suggests that the various courses should be spread over a number of years with appropriate intervals, and that a student should not be expected to devote more than two evenings a week to formal instruction during the technical college year, it is surprising at this stage to find support from such a source for evening classes. It will be recalled that the Percy Committee was most emphatic as to the unsuitability of evening study for the bulk of technical education in engineering, and the Urwick Committee appears to be unduly timid in urging that the study of management should be carried out in part-time day classes. It is still more surprising that the first recommendation in this field by the Percy Committee, that all students of technology, whether at the universities or colleges of technology, should be introduced to these subjects during the final year or two years of their undergraduate course, is not even mentioned.

For all that, the Urwick Report covers a much wider field than the earlier report on Training for Business Administration issued by the committee under the chairmanship of Sir Frank Newsom-Smith. The functions of the Administrative Staff College appear to lie outside the terms of reference of the Urwick Committee, although one might have expected some comment on the idea of the staff college and of refresher courses for those of mature years, particularly with reference to the final courses or diploma. The merits or demerits of an intensive full-time course of two or three months do not appear to have been considered.

Apart from this, the third section of the Urwick Report, which discusses some wider considerations, is sound and well-balanced and makes a number of important suggestions, particularly as regards work which might be undertaken by the British Institute of Management. The first of these arises out of the lack of comprehensive statistical information illustrating the national facilities currently available for education in management. It is recommended that the new institute should undertake an investigation of the national requirements of men competent to discharge managerial responsibilities, and that the various education departments should compile and publish annually comprehensive national statistics on the volume and distribution of educational facilities in management subjects in Great Britain, including details of the numbers of courses and of students attending them. Other bodies should co-operate so as to synchronize with and include in the official figure such activities as those of the Training Within Industry Scheme, the Business Training Scheme for ex-Servicemen and the work of the Administrative Staff College and of university departments.

The report also recommends that immediate steps be taken to secure an increase in the supply of trained teachers in management, both part-time and full-time. The former might be helped by the professional institutions maintaining, through their local organisations, a list of men and women willing to do part-time work, and by the education departments providing facilities for training such men and women in the methods of teaching. The report also welcomes the recommendation of the Percy Committee that at least one institution should be selected as a centre for post-graduate study of industrial administration. This, however, is regarded as insufficient, and it is suggested that the Regional Advisory Councils for Further Education which are being established should be asked to deal, as one of their first tasks, with the provision of opportunities for systematic higher education in this field, leading to recognized academic qualifications. It is recommended further that the British Institute of Management should have associated with it from the beginning an Advisory Council on Education for Management, representative of all those interests concerned with this matter. No comment is made on the poor quality of the present literature of the subject in Great Britain, as did the Percy Report, other than attributing the serious lack of original research and of suitable text-books largely to the dearth of suitable teachers of management. Finally, in commenting on the position in the United States, which is described in an appendix, the Committee recommends that a commission of inquiry should visit that country to report on the facilities for education in management there as compared with those provided in Great Britain.

Uhe Urwick Report may thus be welcomed by all who believe that it is no longer sufficient to appoint as managers those who have shown ability perhaps in some quite different field. If it makes no substantial contribution to the vexed question as to how best we can pick the outstanding administrator for the highest positions, it at least indicates how the level of management can be raised and our chances of picking such men increased. Moreover, the recommendations go some way towards facilitating a solution of that major problem of our time—the effective use of the expert in the task of administration whether in the industrial or the government sphere. Although the report has little or nothing to say about training for management within the Civil Service, it makes a real contribution to the practical task of unifying courses of training and securing the most effective use of our limited resources of trained teachers in this subject.

THERMODYNAMICS AND HUMANISM

Time and Thermodynamics

By A. R. Ubbelohde. Pp. vii+110. (London: Oxford University Press, 1947.) 6*s.* net.

THIS little book shows some confusion of aim. I do not think Prof. A. R. Ubbelohde decided clearly what kind of book he wanted to write. According to the preliminary chapter, his intention appears to have been to write on the wider human aspects of thermodynamics, to contribute to scientific humanism, which he defines as the unification of the specialized sciences from the point of view of their human interest. In this and in his explanations of the significance of entropy as providing a direction pointer for time, he is on fairly familiar ground, and though his treatment inevitably calls forth a comparison with the popular writings of Eddington, who covered similar territory with, one must say, considerably more force, he is both competent and interesting.

The body of the book is, however, a fairly straightforward explanation of the laws of thermodynamics, partly classical and partly statistical, which will undoubtedly be helpful to students of the physical sciences, since it will enable them to appreciate some of the more difficult parts of the subject. But the inquiring layman may be repelled by even simple algebra, and he will find the chapter on the second law, which does not differ in any essentials from that found in most text-books of thermodynamics, rather stiff going.

The discussion of the human significance of the laws of thermodynamics, being confined mainly to short chapters at the beginning and the end, is disappointing. Most readers looking for humanistic meanings will turn to the chapter on thermodynamics and life to see what the author has to say; but they will have some difficulty in determining what his attitude really is. He favours, without dogmatism, the very reasonable view that "living organisms are characterised thermodynamically not by any vital power of selection of individual molecules, but by the fact that the organism considered as a unit is continually effecting processes in which the entropy decreases, at the expense of rather greater compensating increases of entropy in the surroundings".

So far, good. Few readers will be inclined to disagree with the author when he explains that living things are entirely unique arrangements for effecting locally such 'disentropic' processes, and, quite unlike anything encountered in non-living matter. But what are we to make of the following: "Currently accepted terminology would describe human control over natural forces and human organisation of inanimate processes as intelligent. The organisation of similar processes within living organisms, which normally involves more complex integration than has yet been achieved through human inventiveness, must be the result of *analogous intelligent inventiveness*" (my italics)? It would be of interest to have this argument developed, though it is not particularly new (*vide* Paley's watch); but the author puts off his readers with the remark: "Full elaboration of the inventor analogy would not be possible without very greatly exceeding the scope of this book. The issues involved are profound."

If I understand it correctly, the argument is that although the chemical happenings in living organisms may be fully in accordance with the laws of thermodynamics, yet the existence of such extraordinarily complex arrangements for utilizing these laws to produce organisms capable of individual activities, and in many cases intelligence, involves something in addition.

Any fresh arguments for this view would be of great interest. What the author actually does is to mention certain lines of argument and dismiss them as outside the scope of the book. For example, he says, "A further point which may be mentioned, but which cannot be developed very far in this book, is that if the human intelligence is able to conceive (at least by negation) of conditions in which the laws of nature, such as the trend in entropy, are not obeyed, it cannot itself be wholly subject to these laws". Or again, "But there is no real promise of ever bridging the gap between the mechanism as a whole and the organism as a whole, through increased human skill. The nature of the difference between mechanism and organism cannot be further resolved without bringing in other considerations about life which lie outside the scope of this book." It is scarcely fair to the reader to raise such points and leave them up in the air. One cannot help wondering how much the author's final conclusion that "human living is part in entropy-time and part outside it" is based on the "other considerations".

I do not want to suggest that I think there are no other considerations which are worthy of attention. They have been stated with varying degrees of cogency and charm by poets and philosophers as well as some men of science. But Prof. Ubbelohde is shy of developing his argument in this direction. He reminds us of the Scotsman's remark to a lady who had been praising the English: "But hae ye ever been able to get one of them into a metapheesical argument?" He refuses to be drawn into metaphysical arguments; but does not mind supporting his point of view by referring to their existence. It is rather curious that he never mentions, though he may imply, the one inevitable teleological conclusion from the second law, that if the world as we know it is steadily running down, there must have been a winding up.

J. A. V. BUTLER

SCHOOL CERTIFICATE BIOLOGY

Essentials of Biology

An Introductory Text-Book for Secondary Schools. By W. F. Wheeler. Pp. xi+266+8 plates. (London: William Heinemann, Ltd., 1947.) 7*s.* 6*d.*

AS was indicated in *Nature* a short time ago (159, 147; 1947), in the teaching of biology a new movement is spreading through the schools, of considerable educational import, the object of which is to relate the biological sciences directly to human life and culture. This movement has proceeded farthest in the new modern schools, and with sixth-form classes in the grammar schools. In each of these cases the topics dealt with depend largely on the interests of the teacher and his class. With no examination restrictions, presentation may sometimes be amateurist and standards rather low; but, at any rate, links of understanding are being established between work in school and some issues in the outside world which are of major significance.

Compared with this, routine teaching of biology in the grammar schools has an academic flavour, with emphasis almost wholly on the 'essentials' of the subject, hinged as it is on the twin pillars of School and Higher School Certificate. Although the syllabuses for these examinations are gradually being altered in accordance with modern views, their present scope and outlook find clear reflexion in a new text-book of biology by W. F. Wheeler for the School Certificate. Judged by text-book standards, he has achieved a useful piece of work. Apart from minor slips of emphasis and fact, the subject-matter is sound, well set out upon the page and supplemented with many helpful diagrams and photographs. The practice of reproducing line drawings giving details not referred to in the text is, however, open to question, and so is that of including material considerably more advanced without indicating at what stage it will be required. The lot of the young pupil will not be made any easier by the involved language in which the subject-matter is expressed, for it is by no means simple English. As for presentation, the author has given special prominence to human anatomy and physiology, with a useful section on human reproduction. The rest of the book follows the type method of description, both for animals and plants, so that function follows structure, although towards the end there are short chapters on such subjects as the organism and its environment, growth and multiplication, and evolution and classification.

Yet, with its concentration on 'essentials', the book conveys a curious picture of the living world. It is for the most part a two-dimensional picture of morphological and histological details, each with its appropriate technical term duly emphasized in heavy print. It is a picture lacking in unity, purpose or emotional appeal, detached on one side from personal responses to the riches of wild Nature, and on the other from the interests and needs of man, whether material, social or philosophical. To points such as these Mr. Wheeler may justly reply that they do not fall within the syllabus. To that extent the School Certificate is in danger of leaving biological thought in a state of arrested adolescence. Are these 'essentials' really so necessary; and what is their educational significance? R. WEATHERALL

THE LINNEAN HERBARIUM

A Catalogue of the Linnean Herbarium

Compiled and annotated by Spencer Savage. Pp. xv + 225. (London: Linnean Society of London, 1945.) 40*s.* net.

THE Linnean Society of London has been well served by its historians and cataloguers. The late Dr. B. Daydon Jackson, general secretary from 1902 until 1926 and curator of the Linnean Collections during 1926–27, the late Lieut.-Colonel A. T. Gage, assistant secretary and librarian from 1924 until 1929, and Mr. S. Savage, the present assistant secretary and librarian, have been notable recorders of the history of the Society and have done much to make the Linnean collections serve their full purpose in taxonomy. Daydon Jackson published in 1907 (in the *Proceedings of the Linnean Society*) an article "On a Manuscript List of the Linnean Herbarium" to which was appended a "List of the Genera in the Linnean Herbarium". As a supplement to the *Proceedings* for the 124th Session, 1911–12, he published an "Index to the Linnean Herbarium". In both of these works there is much information of value to those wishing to consult the collections. Neither, however, is a catalogue even approximating in scope to that prepared by Mr. Savage.

The present work is not only a list of the specimens in the Linnean Herbarium but also "includes, with as much detail as was considered necessary, the inscriptions up to the time of Sir James Smith's death in 1828—i.e., before the Herbarium came into the Linnean Society's possession". The sequence of the Catalogue is the same as that of the Herbarium.

A great deal of trouble has been taken by Mr. Savage to interpret the various signs used by Linnæus. Six of these signs are of special importance since they probably indicate geographical areas from which the specimens were obtained. It is suggested that Linnæus's liking for brevity was linked with a certain amount of secrecy in dealing with Russian specimens, including those he obtained from Asiatic Russia.

Particularly difficult and time-consuming was the correct attribution of the eighteenth-century handwritings in the Linnean Herbarium. Most of the inscriptions are in Latin and in what is termed 'Italian cursive hand', which shows various national characteristics. The following national handwritings are recorded as present in the Herbarium: Italian, French, Dutch, Spanish and Portuguese, Swiss, Russian, German and Austrian, Swedish, and British. Much of what Mr. Savage has to say on these handwritings will be of value to biologists who have to read and interpret manuscripts and labels written in the eighteenth century. The difficulties of interpreting such handwritings are numerous. One learned Swede wrote three distinct handwritings—"a script hand for Swedish, an Italian cursive hand for Latin, and a form of Court hand for ceremonial occasions". Linnæus's own handwriting is often very difficult to read and deteriorated considerably in his later period. He more and more sacrificed legibility to speed and tended to omit portions of letters. In the present Catalogue are photographic reproductions of seventy-two specimens of handwriting, mostly about half size. These make a valuable and interesting series.

Naturally much of what Mr. Savage records has a bearing upon the sometimes difficult problem of the typification of Linnæus's species. He does not, however, enter into details. He records that "Linnæus 'wrote up' specimens, but by no means entirely, on a 'type specimen' basis. He *sometimes* wrote the species number only on an added sheet, but there are many instances where several sheets have been 'written up' by him." Examination of specimens in the Linnean Herbarium does not eliminate the need for a careful study of Linnæus's descriptions and of the synonyms cited by him. The existence at the British Museum (Natural History) of Clifford's herbarium, upon which Linnæus's "Hortus Cliffortianus" is based, must not be forgotten. In fact, it is not sufficiently consulted in the 'nailing down' of Linnean species by typification.

Mr. Savage is to be thanked for the arduous task he has brought to completion, and the Linnean Society praised for the publication of the Catalogue in times so difficult as those of the present.

W. B. TURRILL

RADIO REFLEXIONS FROM METEORIC IONIZATION

AT a meeting of the Physical Society held on January 31, the results of several recent researches by radar and radio methods into ionospheric ionization effects produced by meteors were described. The *E*-layer of the ionosphere, which occurs in a region around a height of 100 km., is characterized by one regular and two irregular forms of ionization. The regular ionization, the normal *E*-layer, is known to be controlled in a uniform manner by ultra-violet radiation from the sun. The problems of the origin and control of the irregular forms, which for many years have been largely a matter for speculation, were the subject of the papers presented at the meeting. In 1932, A. M. Skellett[1] in the United States had suggested that meteors were an important agency in producing irregular ionospheric ionization, and with J. P. Schafer and W. M. Goodall[2] he gave experimental evidence of certain increases in ionization which could be associated with meteors. Although the experimental data which accrued in subsequent years appeared on the whole to support Skellett's suggestions, it is only by the recent work, particularly in Great Britain, that a more comprehensive account of the complex characteristics of the irregular ionization in relation to the meteoric theory could be given.

The irregular ionization can be classified into two types, which are distinguished most clearly by the radio-frequency at which echoes may be obtained and by their duration. The abnormal or sporadic *E*-layer occurs spasmodically for minutes or hours with a critical frequency greater than, but of the same order as, that prevailing in the normal *E*-layer. On the other hand, ionization bursts are characterized by the transient radio echoes which rarely persist for many seconds, the majority lasting only a fraction of a second; and with high-power transmitters, these echoes may be observed at frequencies greatly exceeding the critical frequency of the other *E*-layers, although the number of echoes diminishes as the frequency is increased.

Sir Edward Appleton gave the opening paper at the Physical Society's January meeting, describing recent investigations carried out with R. Naismith for the purpose of comparing the incidence of the bursts of ionization with the abnormal *E*-layer ionization and of determining their relation both to the incidence of meteors and to the normal *E*-layer. The observation of the ionization bursts was made at 27 Mc./s. with a high-power equipment having a wide aerial beam with its axis vertical. An analysis of the diurnal variation of the rate of occurrence of the radio echoes showed that the form of the night-time curve was almost constant, but the day-time portion was found to alter with the season of the year. A characteristic minimum was found to occur at 1800 hr. local time throughout the year, and both the rate of occurrence and duration increased as the night progressed. In the winter, the number of bursts reached a maximum at about 0500 hr. In summer, however, the increase was found to continue until the maximum rate was reached just before or at local noon. The seasonal variation in hourly rate at noon showed a maximum burst-activity in summer; but the relation is not symmetrical, the rates being greater in the latter half of the year than in the first. These facts may be explained on the hypothesis that the ionization bursts are caused by meteors, while a marked degree of solar control is exerted over the responsiveness of the upper atmosphere. Thus, the hourly rate of sporadic meteors is known to be greater after midnight than before, and greater in the second half of the year than the first. On the other hand, the sun causes the normal *E*-layer ionization to reach a maximum near noon, the ionization being greatest in summer. A combination of these two factors would account for the observed diurnal and seasonal variations in mean rate of occurrence.

The controlling influence of the normal *E*-layer is exhibited in a parallel way in the case of the abnormal *E*-layer, which, for example, during the day shows diurnal and seasonal variations of height similar to those of the maximum normal *E*-layer ionization. Further, it is known that the abnormal *E*-layer has shown increases at the time of large meteor showers. The Giacobinid shower of October 10, 1946, afforded a particularly striking example. The remarkable increase in the number of ionization bursts at this time has been reported previously[3].

There is thus a general parallelism between the two phenomena of the bursts and the abnormal *E*-layer; and it is suggested therefore that, at least in temperate latitudes, meteors are the agency primarily responsible for both these forms of irregular ionization, although the ionizability of the medium exerts a very marked effect. This controlling effect is revealed in the day-time influence of the normal *E*-layer. The ionization bursts are pictured as being associated with individual meteor trails. That there are many more echoes than visible meteors is understandable, since the greater proportion of meteors may be expected to be too small to produce visible trails.

Sir Edward Appleton also referred to the observations he made with Naismith and the B.B.C. of the meteoric Doppler whistles heard in radio sets tuned to the unmodulated carrier of short-wave radio stations, which were first reported by the Indian workers, Chamanlal and Venkataraman[4]. He suggested that the changing pitch of the whistles could be accounted for by the changes in relative velocity with respect to the observer without assuming any retardation of the meteor. The resulting beat-frequency is:

$$f = \frac{2V}{\lambda}\left(1 - \frac{R_0^2}{R^2}\right),$$

where V is the velocity of the meteor, λ the wave-length, R the range and R_0 the perpendicular distance to the track.

J. S. Hey then gave an account of the researches he had carried out since 1944 with G. S. Stewart at the Operational Research Group, Ministry of Supply, at frequencies around 60 Mc./s. Such high frequencies limit observations to the more intense ionospheric bursts, and it was found that the transient echoes could then be more specifically related to meteors, with far less evidence of any controlling influence exerted by normal *E*-layer ionization. Thus peaks in the rate of occurrence were found to correspond to well-known meteor showers[5]. The height distribution was determined by means of an aerial beam with its axis vertical, due allowance being made for the effect of beam-width. The mean height of maximum occurrence was found to be about 95 km., and 90 per cent of all echoes occurred between

87 km. and 108 km. This height agrees well with the visually observed heights of meteors and their trains.

Observations made with radio beams having their axes inclined at elevations around 45° revealed the important influence of the direction of observation on the apparent rate of occurrence. In an experiment carried out with the help of A.A. Command during June and July 1945, stations at Walmer (Kent), Aldeburgh (Suffolk) and Richmond (Surrey), respectively, were set so that their aerial beams made broad intersections at heights around 100 km. Simultaneous observation of echoes from the three stations was a rarity, thus indicating marked aspect sensitivity in the echoing sources. This was further confirmed by the diurnal variations in rate of occurrence, which were markedly different for the three stations. The aspect sensitivity was shown to be readily explained when the transient echoes are interpreted as the broadside reflexions from meteor trails, which may be expected to show aspect variations in reflexion like those for long cylinders, as was first suggested by J. A. Pierce[6]. Thus, as the elevation and bearing of the active radiants change with the earth's daily rotation, corresponding changes occur in the optimum direction for obtaining radio reflexions. In fact, by finding the optimum directions experimentally, it has been found possible in certain instances to derive the positions of the radiants of the most active meteor streams.

Finally, during the Giacobinid meteor shower of October 10, 1946, not only were records obtained of the broadside reflexions from meteor trains (which show relatively only small range-movements due to drifts and turbulence); but also, by improved photographic techniques, the reflexions from the ionization in the immediate vicinity of the approaching meteors were recorded in certain instances. These observations and the derivations of meteor velocities were described in detail at a meeting of the Royal Astronomical Society on December 13, 1946[7,8]. During part of a shower, a watch for echoes at a frequency of 212 Mc./s. was also maintained, and the number of echoes was about one tenth of the number on a 64 Mc./s. equipment of similar power and beam width.

Dr. E. Eastwood described the investigations of ionospheric bursts of ionization which he has conducted in association with K. A. Mercer at a number of R.A.F. radar stations during 1945–46. The aerial systems gave fixed beams covering low angles of elevations over almost all bearings. Systematic observations, made over nineteen months at the Bawdsey station on a frequency of about 23 Mc./s., showed that the rate of occurrence of bursts follows a diurnal cycle with peaks at approximately 0400 hr. and 1200 hr. G.M.T. and a pronounced minimum in the afternoon. The precise form of the diurnal cycle, however, proved to be dependent on the season. The relative amplitude of the two peaks varied seasonally, but the afternoon minimum was found to be a feature of all the daily curves. The change in daily volume of activity showed an annual cycle with a maximum in the autumn and a minimum in the spring. These experimental results, as in the case of those obtained by Sir Edward Appleton and R. Naismith, were therefore in accord with the theory that attributes the bursts to ionization by sporadic meteors in an atmospheric medium subject to a marked degree of solar control.

The height of the bursts was determined from the minima in the histograms of range-distribution. These minima could be related to the minima of the aerial beam pattern which occur at several elevations as a consequence of the interference between the direct wave and that reflected from the ground. It was concluded that most ionization bursts are produced within a thin layer located at a height of approximately 85 km.

The magnitudes of the echoes were studied by using a single dipole aerial system. The derivation of the distribution function for the magnitudes showed that, for a given frequency, the number of bursts per unit area per unit time having equivalent echoing areas between A and $A + \delta A$ is proportional to $\delta A/\sqrt{A^3}$. The results of observations with equipments operating in the frequency bands 20/30 and 40/50 Mc./s. indicated that the number of bursts was also inversely proportional to the square of the frequency.

An examination of the burst-activity for local variations was made by comparing the results at different stations in England and Scotland. Although at any given time random fluctuations were found from place to place, the average activity was constant over wide areas. Further, the results obtained during the partial solar eclipse of July 1945 did not reveal any influence on the phenomenon of burst-activity.

Dr. A. C. B. Lovell described the investigations at a frequency of 73 Mc./s. which he had carried out with C. J. Banwell and J. A. Clegg in continuation of the observations of the Perseids and Giacobinids described before the Royal Astronomical Society on December 13, 1946[8]. By using the narrow-beam aerial system maintained at right angles to the direction of the radiant, the main characteristics of the 1946 Leonids, Orionids, Taurids, Geminids and 1947 Quadrantids were measured. The most important results were as follows:

(1) In the two richest showers (Geminids and Quadrantids), a striking correlation of hourly rate with radiant altitude was observed. The rate remained low (5–10 per hour) until the radiation attained an altitude of about 40°, when it increased suddenly to about 45 per hour for the Geminids and to about 60 per hour for the Quadrantids. The reverse effect was observed when the radiant was setting.

(2) Although the velocities of these meteor showers are known from visual observations to vary over a wide range, the distribution of durations of the echoes from all these five showers was identical. 60 per cent of all echoes in the showers lasted for less than 0·25 sec. Only 1 per cent had durations in excess of 10 sec. This result is important in the development of the theory of the decay of the meteor ionization, since it implies that the height at which the ionization is formed is not the principal factor determining the duration of the echo.

(3) The distribution in intensity of ionization for the Geminids and Quadrantids was calculated using formulæ given previously[8]. In each case the distribution was the same as that for the 1946 Giacobinids, namely, that the number of occurrences of ionization of a given intensity was inversely proportional to the intensity. In conjunction with Herlofson's theory of meteor ionization, this shows that the number of meteors of a given size is inversely proportional to the size of the meteors. This result agrees with the visual estimates that there is the same total mass of meteoric material in each magnitude.

The work of Chamanlal and Venkataraman[4] was further described by G. R. M. Garratt who, during a recent visit to New Delhi, was given an opportunity of listening to the meteoric whistles, which were first reported by the Indian workers when listening to the short-wave transmitters of All India Radio. The whistles normally lasted about 2–3 sec., fell rapidly in pitch to zero or sometimes died away before reaching zero, and only in rare cases did the whistle reappear as an ascending note after passing through zero. Chamanlal and Venkataraman considered that these characteristics could be explained on the assumption that they were due to interference between the directly received ground-wave from the transmitter and the reflected waves which have undergone a Doppler change of frequency owing to the movement of the reflecting surface. The velocities deduced were similar to those of meteors, and the suggestion that the reflexions were associated with meteors was confirmed by direct correlation between the occurrence of a whistle and the arrival of a visible meteor. Mr. Garratt outlined the conditions for satisfactory reception of the meteoric whistles; namely, a high-power transmitter radiating an unmodulated signal at a frequency of the order of 5–15 Mc./s., and a highly sensitive receiver located within the skip distance in a position such that a very weak ground-wave is received from the transmitter. The whistle effects can be heard on almost any night of the year, the greatest number being observed about 4 a.m.

Finally, the recent investigations in the United States by J. A. Pierce[9] were outlined by K. R. Eldridge. During the Giacobinid shower of October 10, 1946, about 3,500 Doppler whistles were recorded. Pierce considered that the Doppler effect is produced by an 'ionic bow-wave', the pitch being a function of both the velocity of the meteor and the rate of diffusion of the electrons. The pitch is presumed to fall from the first, because the growth of the cloud of ions is most rapid at its initial height, and goes to zero when recombination prevents further expansion of the boundary.

Correlations between the whistles and visually observed meteors were obtained when weather conditions permitted. In the case of two whistles, which were so loud that the visual watchers out-of-doors 40 ft. away could hear them, it was noted that the whistle was heard within the first quarter of the meteor's course, and the tone fell in pitch throughout the period of the meteor's visibility.

Pierce concluded from the average number of whistles observed that his limit of sensitivity corresponded to a third-magnitude meteor. He calculated that the average rate of flow of energy in the four hours during which the Giacobinid shower was observed corresponded to a figure of 3 watts per sq. km. By assuming that the energy was expended in a layer 30 km. thick, and that 15 electron volts are required per ion, it was calculated that the ion density would be of the same order as the maximum density of ionization in the normal E-layer at the sub-solar point. J. S. HEY

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[2] Schafer and Goodall, *Proc. Inst. Rad. Eng.*, **20**, 1941 (1932).

[3] Appleton and Naismith, *Nature*, **158**, 936 (1946).

[4] Chamanlal and Venkataraman, *Electrotechnics*, **14**, 28 (1941).

[5] Hey and Stewart, *Nature*, **158**, 481 (1946).

[6] Pierce, *Proc. Inst. Rad. Eng.*, **26**, 892 (1938).

[7] Hey, Parsons and Stewart, *Mon. Not. Roy. Astro. Soc.*, in the press.

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[9] Pierce, *Phys. Rev.*, **71**, 88 (1947).

METEORS, COMETS AND METEORIC IONIZATION

On March 19 and 20 a conference on meteors, comets and meteoric ionization was held in the University of Manchester Physical Laboratories under the auspices of the Physical Society. The chairman, Prof. P. M. S. Blackett, in opening the conference, remarked that this was probably the first conference of its kind to be held. A widespread interest in meteors and comets is arising because of the new radio methods of detecting the ionization due to meteors in the atmosphere. Results of importance to astronomers and physicists are now being obtained; and it was hoped that this joint gathering would be of benefit to both.

Meteors

In the first lecture, J. P. M. Prentice, director of the Meteor Section of the British Astronomical Association, described the general background of our knowledge of meteors. The following is a brief abstract of his remarks.

(*A*) *Numbers.* The major streams exert a dominant influence on the curve of annual variation, and the rate of occurrence of a given stream is a function of the radiant altitude. The general level of meteor activity after eliminating the major streams is rather low, about 4–10 an hour, and shows daily and annual variations due mainly to the concentration of radiants around the apex of the earth's path. A particular observer sees only a small fraction of the fainter meteors appearing in his zone of vision, so that although the observed numbers fall off after magnitude 4·5, the real numbers continue to increase by a factor 2·3 per magnitude. Beyond the limits of naked-eye visibility, the number of telescopic meteors increases by the same factor at least down to magnitude 10 and probably far beyond.

(*B*) *Radiants.* The divergence of meteors from radiant points is an effect of perspective, showing that the motions of those meteors are parallel and that they form members of one stream. These radiants are apparent radiants, due to the combined orbital velocities of the meteors and the earth. Some twelve major streams are known, of which eight appear annually; in addition, there are many minor streams of varying degrees of tenuousness, and some meteors pursuing individual paths in space properly called 'sporadic'. A very few streams are known from the similarity of their orbital elements to be associated with comets, although the proof is only complete for the three instances (possibly four) in which the periods have been determined. The majority of radiants are not points but large areas of radiation some 10°–15° in diameter.

(*C*) *Paths in the Atmosphere.* The meteor zone lies generally at an altitude between 125 km. and 70 km., though exact limits cannot be assigned. The height of appearance and disappearance is determined primarily by the entrance velocity, although the beginning height is also correlated with the zenithal magnitude. This difference in height is generally a function of zenithal magnitude only, being sensibly independent of velocity and of radiant altitude except for very low radiant altitudes. The heights are determined by simultaneous observations, which also yield the path-length P and the duration of flight t, and hence the observed velocity P/t. There is some observational evidence of a general deceleration due to atmospheric resistance, but this is not universally accepted.

(*D*) *Velocities.* These may be determined by either direct or indirect methods. The principal direct methods are (*a*) by simultaneous observations as above, or (*b*) by observing periodic recurrences of a stream. The indirect methods are (*c*) from the daily and annual variation in numbers (the method of von Niessl[1] and Hoffmeister[2]), and (*d*) from the observed heights, which give more reliable values than P/t. The only really accurate method is the observation of periodic recurrences, as an error of only 0·5 km./sec. usually makes a considerable difference to the orbit; but these recurrences are very difficult to establish. The method of von Niessl and Hoffmeister has led to the belief in hyperbolic velocities as a normal occurrence; but the method is an indirect one and at variance with direct observations and is not considered valid.

Comets and their Relationship with Meteors

The second lecture was given by Dr. J. G. Porter, the director of the Computing Section of the British Astronomical Association, who spoke on the relationship between comets and meteors. Both classes of body are now known to be members of the solar system, travelling around the sun in elliptical orbits; those few cases of hyperbolic orbits which can be substantiated are known to be caused by perturbations of elliptical orbits by the major planets. The head of a comet must possess mass, since it obeys the law of gravitation, but that mass must be very small. All the evidence supports the view that the head consists of solid particles composed of meteoric material. But whereas in a meteor stream the individual particles must be many miles apart (10–20 miles even in the extreme case of the great Leonid shower of 1835), in the head of a comet the distances may be measured in yards. Some force other than gravity is apparently needed, however, to account for the remarkable coherence of the head, which in many comets has undergone enormous disturbances without disruption.

After discussing the effect of planetary perturbations on a meteor stream, Dr. Porter expressed the view that there is no sound evidence that meteor streams are the remains of disrupted comets. The one case which is always quoted—that of Biela's comet—carries very little weight when examined closely. The comet divided into two parts in 1846—apparently without cause—was seen once more in 1852, and then vanished. But in 1872, when the earth crossed the orbit of the comet, a magnificent display of meteors was seen. The meteors could not have been the remains of the head of the comet, for the place where the earth crossed the orbit was far from the computed position of the comet itself. Perturbations by the major planets certainly could not have caused sufficient disturbance in the intervening twenty years to have spread the meteoric matter out over the orbit. All that can be said is that the meteor shower travelled in the same orbit as the comet, and this applies equally to other well-known showers. The Bielids had given good showers before, while the great showers of Lyrids, Leonids and Perseids can all be traced back in history long before the associated comets were discovered.

Actually there are very few accordances between meteor showers and comets—only six of the better-known showers give satisfactory agreement with their associated comets. Yet there are many minor showers for which the parent comet is unknown, and there are many comets which come close enough to the earth to give a shower, but do not do so.

We are forced to conclude that there is no *direct* evidence of the disruption of comets to form meteor streams. All that can justly be claimed is that there are some cases known in which a meteor stream follows the same orbit as that of a comet, and it seems plausible to suggest that comets and meteors have a common origin.

Ionization Due to Meteors in the Atmosphere

In the first lecture of the afternoon session, Dr. A. C. B. Lovell gave a survey of the known effects of meteoric ionization in the earth's atmosphere. Evidence that the ionization in the *E*-region of the ionosphere does not decrease in a regular manner during the night but is subject to abnormal increases was obtained in the early days of the ionosphere work by Heising[3] in the United States, and by Eckersley[4], Appleton[5] and their co-workers in Great Britain. Subsequent work tended to divide the abnormalities into two classes: (*a*) long-duration increases of ionization lasting for minutes or hours, found on frequencies just above the normal critical frequencies (abnormal or sporadic *E*); (*b*) short-duration bursts of ionization lasting for a fraction of a second or a few seconds, which could also be observed on very much higher frequencies. Both effects occurred by day and night throughout the year. As a result of a great deal of work since 1930 by Appleton, Naismith, Ratcliffe and others in Great Britain, and by workers in India and the United States[6], it now seems certain that the long-duration abnormal *E* is associated with two separate effects: (1) the incidence of solar corpuscles, associated with magnetic disturbances and hence most pronounced in polar regions; (2) the ionization due to meteors, which constitute the main abnormal effect in temperate latitudes. With regard to (*b*), Skellett[7] and Schafer and Goodall[8] showed, by a combined visual and radio watch during the Leonid shower of 1932, that the short-duration abnormalities were caused by the entry of meteors into the atmosphere.

After describing subsequent work on the short-duration ionization bursts by Eckersley[9], Appleton and Naismith[10], Dr. Lovell gave a short account of contemporary studies of the effect using frequencies in the 60–70 Mc./s. region, which are high enough to be clear of the confusing effects of the longer duration abnormal *E*. Hey and Stewart have investigated many of the properties of the radio echoes from meteors and have succeeded in determining radiants[11] and velocities[12]. In the determination of velocities, these workers were able to photograph a faint fast-moving echo prior to the formation of the main radio echo. The analysis of twenty-two such photographs during the Giacobinid shower of October 1946 gave a velocity of 22·9 km./sec., in close agreement with the value of 23·7 km./sec. expected from theoretical considerations. The lecture concluded with a short account of the work of the Manchester group, who have explored the major streams by using a narrow beam aerial which can be directed to any point in space. For the meteors in the Giacobinid, Geminid (1946) and Quadrantid (1947) showers the intensity of ionization giving rise to the radio echoes has been calculated[13]. The distribution in number of these intensities obeys an inverse power law with an exponent close to unity. On Herlofson's theory of meteor ionization (see later) this also gives the distribution of meteor masses in the stream—

a result in agreement with visual observations that the mass of meteoric material in each magnitude is the same. These measurements also show that a meteor which is just visible to the naked eye produces about 10^{10} electrons/cm. path—a result which is again in good agreement with Herlofson's theory[14]. Dr. Lovell ended by showing a ciné film of the radio echoes during the maximum of the Giacobinid shower in October 1946, when the echo-rate reached an enormous peak of 160 per minute for a very short time, compared with the normal no-shower rate of one or two per hour on this apparatus.

Theory of Meteor Ionization

N. Herlofson then gave an account of the theoretical aspects of meteor ionization in the atmosphere. Observations by the Manchester group, referred to above, show that the echoes recorded by their apparatus, at 4 metres wave-length, are due to scattering from columns of electrons with densities of 10^{9}–10^{11} electrons per cm. length. These values are in reasonable agreement with quantum-mechanical estimates of the ionization produced by meteors visible to the naked eye, or somewhat fainter. The majority of the echoes disappear after less than one second, a great number lasting only a few tenths of a second; but durations of some seconds are not uncommon, and durations up to 100 seconds have been recorded.

So far, all attempts to find a correlation between duration and height in the atmosphere have been unsuccessful. Another remarkable feature is the occurrence of strong and rapid fluctuations in the intensity of a number of the longer echoes.

A study of the scattering from electrons with a radial Gaussian density-distribution suggests that diffusion is important for the rate of decay of the echoes. Electrostatic forces prevent a separation of the electrons and the positive ions, and the effective diffusion coefficient for the ionized matter will be a weighted mean of the diffusion coefficients for electrons and for positive ions. In a direction normal to the magnetic field of the earth, the diffusion of the electrons will be hampered by the electromagnetic force, while the electromagnetic force does not affect the diffusion in a direction parallel to the magnetic field lines. The resulting elliptical distribution of electrons around the track of the meteor will present its broad side to the radio station in the regions of the sky 90° away from the magnetic zenith, and its sharp edge if it appears close to the magnetic zenith. Therefore, the duration of the echoes will depend both on height in the atmosphere and on the angular distance from the magnetic zenith to the reflexion point on the meteor trail. In Northern Europe, a belt near the northern horizon will be favourable for echoes of long duration, and some observational evidence already exists in support of this conclusion[15].

The wind systems revealed by visual observations of the rare luminous trails, lasting for half an hour or more[16], show that meteor trails can be expected to deviate from a straight line by several metres even after one second. Such deformations can produce a sudden increase of the echo if part of the trail is brought to coincide with one of the spherical wave surfaces. Further deformations may lead to several reflexion points along the trail, and the observed oscillations in echo intensity can be explained by the varying phase difference in the radiation scattered from the various reflexion points.

Since only deformations *along* the radius from the radio stations are effective, and winds are mainly horizontal, oscillations will preferably occur in echoes observed at low elevations. Combining this conclusion with the expectation of long-duration echoes near the northern horizon, it is possible to understand that long durations are frequently accompanied by fluctuations in intensity at stations in the British Isles.

Observations in equatorial latitudes, where the magnetic field lines are nearly horizontal, can provide a decisive test for these suggestions. We should expect to find echoes of long duration decaying *steadily* near zenith, echoes of long duration showing fluctuations near the eastern and western horizon, and echoes of shorter duration near the northern and southern horizon.

On March 20, the conference was continued informally at the Jodrell Bank Experimental Station of the University of Manchester, where the apparatus in use by the Manchester group of workers was inspected.]

A. C. B. LOVELL

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NUTRITION AND SYMBIOSIS*

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NUTRITION may be taken to include all those processes by which chemical substances essential to the life of a given species, be it plant or animal, become available for anabolism. Thus in plants, nutrition includes photosynthesis and root absorption, as well as the processes of digestion which occur in animals and insectivorous plants. The term 'symbiosis' in its original and widest sense signifies any phenomenon, from a balanced parasitism to complete mutualism, in which each partner gains nutritional benefit from the presence of the other. Such diverse phenomena as the harbouring of specific fauna and flora in the gut of insects and vertebrates and the occurrence of algæ in the cells of *Hydra viridis* are, in the widest sense of the term, symbiotic.

Symbiosis is a phenomenon of very general occurrence in both the plant and the animal realms.

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* Paper read before the Society for Experimental Biology on September 25, 1946.

Examples are known in almost all classes of plants. The consortium of alga and fungus exhibited by the lichen is the classical example. Mycorrhiza is found not only in conifers but also in deciduous trees and other flowering plants, and in the ferns. A parallel phenomenon is encountered in the bryophytes[1]. Bacteria causing root nodulation occur not only in legumes but also in other widely different plants, for example, *Alnus* and *Cycas*. In the animal kingdom symbiosis is a very common occurrence, particularly in the wood-eating insects such as the termites, and in the larvæ of wood-eating roaches, of wood-wasps and of other insects which subsist on a diet rich in cellulose[2].

Though many examples of symbiosis have been known for more than a hundred years, evidence for mutualism is still being examined. Even when, as with the mycorrhizas of forest trees, investigations are still in a highly debatable stage, the evidence for mutualism is increasing, for very often a particular species of fungus fructifies, in Nature, only on litter beneath trees on which it forms mycorrhizas, while conversely the healthiest of forest trees have mycorrhizas.

It may be much easier to prove the dependence of one partner than that of the other. Thus in the germination of orchid seeds it has been shown that the seeds of some species need to be attacked by their specific fungal associate at germination, while others need the fungus for continued development. The simple embryo of the orchid, though small, contains a food reserve in the form of oil, and it has been suggested that the fungus may in some way render the oil more readily available to the developing embryo. The dependence of the orchid *Goodyera repens* on its fungus is of this type[3]. The dependence, however, goes beyond assistance at germination, for, on sugar, growth is limited, and to complete its development *Goodyera repens* needs to be penetrated by its fungus even if sugar has produced its early development. In pine trees the dependence seems to be of a different kind. Successful germination occurs in the absence of the fungus, though it is claimed that establishment of mycorrhiza is necessary for production of thrifty trees[4].

In the humus-rich soils of forests, sporophores of mycorrhiza-forming fungi are common[1]. There is an analogy here between such humus-inhabiting fungi living in what is really the excreta of trees, and the bacteria found in the alimentary tracts of animals of a wide variety of species.

Symbiosis may be raised to the status of mutualism if it is proved that the apparently parasitized partner actually benefits from the parasitism. The root nodulation so common in legumes is an example of mutualism[5,6]. In exchange for energy-producing nutrients, the *Rhizobium* provides chemically combined nitrogen to the host, so that the overall effect is that the legume can grow in a culture solution devoid of combined nitrogen[5,6]. Dependence in this instance, however, has not become obligatory, for both the *Rhizobium* and its host can have independent existences if their respective environments permit, the *Rhizobium* saprophytically and the legume holophytically.

The fixation of nitrogen by *Rhizobium*, *Azotobacter* and *Clostridium pasteurianum* has led to investigations of the possibility of the fixation of nitrogen in other symbiotic associations. Thus Cleveland attributed nitrogen fixation to the protozoans (*Hypermastigota*) inhabiting the hind-gut of certain species of termites. This fixation has not so far been confirmed. Cleveland[7] based his conclusions on observations of the effects of diet and defaunation on the longevity of the termites. Since starving insects may remain active for very long periods, such methods of observation need careful control.

The claim by Peklo[8] to have demonstrated fixation of atmospheric nitrogen by symbionts in the mycetomes of aphids rests on stronger grounds, since he claims to have identified the symbionts as species of *Azotobacter* and refers to the work of others who investigated the rate of acquisition of nitrogen by aphids. Even in these cases, there is the possible explanation that nitrogenous metabolism of insects may be much more efficient than that of mammals. In any attempts to repeat Cleveland's experiments the use of isotopic nitrogen would be very advantageous. The fixation of nitrogen can be proved only by demonstrating a real increase of the nitrogen content of an organism or of the medium in which it is growing. An increase in the percentage of nitrogen, such as occurs in the decay of plant materials due to bacteria or fungi, usually means merely that dry matter has been lost as carbon dioxide.

A symbiotic relation between bacteria and animals is the basis of the commonest method by which various land animals digest cellulose, for the secretion of cellulase, as happens in the snail and in certain wood-eating insects, is uncommon. In the cæcum and in the colon of the mammal, microscopic examination shows that bacteria are mainly responsible for the power of mammals to digest cellulose-containing materials. Pre-eminent, however, in this regard are the ruminants, both wild and domesticated. In them the paunch, an enlargement of the œsophagus, forms a fermentation vat teeming with bacteria and highly specific protozoans. Because of their fascinating appearance under the microscope, the protozoal inhabitants of the rumen have been the subject of more speculations as to their mutualistic functions than have the bacteria. All experimental work, however, has so far proved the over-riding importance of the bacterial symbionts in ruminant digestion. It is more than fifty years since German biologists[9] suggested that the rumen bacteria conferred a benefit on their hosts by elaborating digestible materials in their own bodies: only in the last few years, however, have these benefits been in any way adequately or rigorously defined. We now know that the rumen bacteria synthesize protein from ammonium nitrogen in the rumen and that they store carbohydrate as bacterial polysaccharide[10]. We also know from experiments in which such bacterial bodies have been fed to rats that their protein is available for anabolism after digestion by the host. Similar biochemical and microbiological changes occur in the cæcum of the horse, the rat, the rabbit, the guinea pig and the pig, in the cæcum of the ruminant itself, and in the colon of mammals generally, and serve to explain the very variable powers of digesting cellulose found in different mammalian species. In all species so far examined, it appears that such digestion of cellulose as occurs is due to bacteria morphologically describable as cocci but not so far further characterized. There have in the past been claims to show that in the paunch of the ruminant the protozoans also digest cellulose, but in this case mere microscopic examination is of little value because it is impossible to tell whether such apparent cellulolysis is due really to protozoal secretions or to the activities of bacteria adhering to the surface of the plant fragments ingested by the protozoans. Hungate[11], however, claims to have prepared a cellulase from rumen protozoans fed in isolated culture on non-cytoclastic bacteria.

An important effect of the bacteria in the rumen is their production, from sugar, starch, cellulose and other carbohydrates, of quantities of lower fatty acids. Phillipson and his colleagues at Cambridge have investigated the production of lower fatty acids in the rumen of the sheep, and have discovered a great preponderance of acetic acid[12,13]. McNaught and Smith[10] have shown that liquor, carrying its mixed bacterial flora, abstracted from the rumen of the steer, produces acetic acid from carbohydrates when incubated *in vitro*. Moreover, Phillipson and his colleagues have shown that acetic and other lower fatty acids are directly absorbed through the walls of the sheep's rumen, whence they pass via the portal circulation to the liver. Thus, much of the carbohydrate of its diet is made available to the ruminant by mutualistic symbiosis. The ruminant provides the bacteria with their preferred substrate, and in return has part of its carbohydrate digested for it.

Investigations of the causes of the deficiency diseases beriberi and pellagra, which occur in the more poverty-stricken parts of the world, led eventually to the unravelling of the complex collection of organic micronutrients necessary for animal life which we now call the vitamin B complex. The members of this complex now number more than ten, and the identification of further members is proceeding. The identification of these vitamins of the B-complex and the demonstration of their occurrence in practically all forms of life, whether green plants, fungi, protozoans or mammals, has greatly increased the number of instances of symbiosis which must now be regarded as true cases of mutualism.

There is no mystery as to the origin of the vitamins n the body or in the milk of a cow, sheep or other grass-eating or browsing animal. Green leaves seem to be portmanteaux packed with all essential animal nutrients[14,15]. Cows, however, often exist in winter on diets in which sufficient of the members of the vitamin B complex cannot be demonstrated. Such animals secrete in their milk and urine much more of certain members of the B-complex, for example, riboflavin and nicotinic acid, than can be found in their diet. Factors of the B-complex are synthesized by the symbionts inhabiting the rumen, probably by the bacterial symbionts, though this last point is still in need of rigorous proof[16].

Other animals have been found to be independent of an external source of the B-complex. Indeed, what is now known to be a mutualistic association of the rat and its intestinal bacteria was once the cause of much trouble in early attempts to assay members of the B-complex by using rat-growth as an index. Certain rats on experimental diets free from the vitamin under test were found to suffer no disability, whereas others succumbed on the same diet. Fridericia[17] in Denmark showed that the ability to withstand such deficiencies is not necessarily due to coprophagy, that is, the eating of their own droppings, but is due to a power developed by some rats of synthesizing the vitamins of the B-complex. Later investigations have shown that it is the bacteria inhabiting the gut which synthesize the B vitamins for the refected rat, because such refection is inhibited by dextrinizing the raw starch in the diet or by adding filter paper to the diet. It is also either inhibited or diminished by surgical removal of the rat's cæcum or by the administration of non-absorbable sulphonamides such as succinyl sulphathiazole[18-20]. In this last type of experiment, Light and others[21] have shown that growth is resumed when rats ingesting sulphonamide are allowed to eat fæces of rats on the same diet but without the sulphonamide. In the rat, and perhaps in the ruminant, it has been shown that the fat-soluble vitamin K can also be synthesized by symbiotic bacteria.

There is evidence that even in man himself[22], in certain circumstances which still need accurate definition, the bacteria in the large bowel can synthesize aneurin and niacin[23]. In the rat and the mouse, evidence has been produced which suggests that some members of the B-complex, for example, inositol, are not needed directly by the animal but as micronutrients for its symbiotic bacteria[24]. The power of man's own symbionts to synthesize members of the B-complex may explain why the incidence of such diseases as beriberi and pellagra varies markedly in areas where they are endemic.

Circumstantial evidence as to the obligate nature of the symbiosis of insects and bacteria or actinomycetes is provided by studies of the manner in which these symbionts reach the eggs of the host, cases being known where the embryo is infected at the time of laying and before the egg-membrane is formed. Mansour and Mansour-Bek[25] believe that such evidence does not justify the attributing of mutualism to such symbiosis. In many cases, however, mutualism has received rigorous proof. Thus Rosenkrantz[26] in 1939 demonstrated the presence of symbiotic bacteria in stink bugs (Hemiptera, Heteroptera), and showed the presence of organs in the body, the function of which is to ensure that eggs become infected as they are laid. In twenty-three families of the same group (Heteroptera), Schneider[27] showed that larvæ hatching from such eggs developed normally, whereas larvæ from sterilized eggs survived only six to nine days. Brecher and Wigglesworth[28] have shown that when deprived of its actinomycetes *Rhodnius prolixus* rarely reaches the imaginal stage, and that any imagos which are produced are sterile unless they are allowed to become re-infected with the actinomycete. Growth is resumed when larvæ are allowed to become re-infected.

In the hemipterous insect *Cicadella viridis*, Mahdihassan[29] has demonstrated two bacterial symbionts, one producing a green pigment, sarcinene, and the other producing β-carotene. Mahdihassan states that β-carotene is needed by the insect, which changes it to vitamin A. This observation, if confirmed, is a case of mutualism affecting a fat-soluble vitamin other than vitamin K.

Perhaps the most interesting case of symbiosis affecting synthesis of the B-complex is in the insects investigated by Blewett and Fraenkel[30], who were comparing the susceptibilities of various grades of flour to damage by insects. Fraenkel and Blewett raised insects from disinfected eggs. The insects investigated were two beetles which commonly infest stored flour and grain, *Lasioderma serricorne* and *Sitodrepa panicea*. They had noted in earlier researches that *L. serricorne* and *S. panicea* did not appear to require certain members of the B-complex in their diets because they could develop normally in flour of 75 per cent extraction (N.S.R.), while two other beetles also infesting grain and flour, *Tribolium confusum* and *Ptinus tectus*, could not grow normally on National Straight Run flour unless yeast was added. *Tribolium* and *Ptinus* developed normally on wholemeal flour. In many insects symbiotic bacteria or fungi are enclosed in special organs called 'mycetomes'. Microscopic examination of Fraenkel and Blewett's beetles showed that the former two species which could do without the B-vitamins possessed mycetomes containing symbiotic yeast-like organisms while the latter two species did not. Fraenkel and Blewett, therefore, supposed that *Lasioderma* and *Sitodrepa* were dependent on their symbionts for their supplies of essential water-soluble vitamins. They proved the truth of their hypothesis by showing that in the absence of their symbionts, *Lasioderma* and *Sitodrepa* lose their power of living on a diet lacking certain members of the B-complex. They also showed that, when freed from symbionts by being hatched from sterilized eggs, *Lasioderma* and *Sitodrepa* behaved in much the same way as did *Tribolium* and *Ptinus* when subjected to diets deficient in certain members of the B-complex.

To summarize these observations on symbiosis and nutrition, it may be said that examples of symbiosis which have long been known have, by morphological and biochemical researches, been raised in some cases to examples of what we may call mutualism.

The fixation of nitrogen by *Rhizobium radicicola* living in the roots of legumes proves this symbiosis to be a case of mutualism.

While mycorrhiza is essential to the normal development of the orchid, it is not essential to the life of the fungus producing it, for the latter lives quite successfully as a saprophyte in dead pine needles, or even when grown in a simple synthetic medium with dextrose and mineral salts. In those orchids which are devoid of chlorophyll, the mycorrhizal condition is associated with a completely saprophytic habit, and the dependence of the orchid on the fungus is obvious.

The manner of establishment of mycorrhiza varies in different plant orders for, while orchid seeds are shed quite free from fungus, the grains of the rye-grass *Lolium* are regularly infected. The mechanism of infection in *Lolium* is reminiscent of the method found in certain insects in which the eggs are automatically infected before they are laid. The status of the mycorrhizas of forest trees still has to be decided. Circumstantial evidence is, however, strongly in favour of a real dependence of such trees on their mycorrhizal fungi.

In ruminants, symbiotic bacteria, yeasts and protozoans inhabit the paunch. Similar microbiological pictures are shown by the cæcum and colon of various mammals, including man. That the bacteria in all these cases benefit their hosts is not easy to prove. That the bacteria of the paunch of ruminants do, however, benefit their hosts has been shown by the following observations: (1) Rumen bacteria digest cellulose whereas the ruminant itself cannot[31,32]. (2) They generate acetic acid from carbohydrates and thus assist in their digestion. (3) They elaborate protein from ammonium nitrogen, and this protein, together with bacterial polysaccharide, becomes by autolysis and normal digestion available to the host[33,34]. The elucidation of the chemistry of the water-soluble vitamins of the B-complex has shown that many bacteria inhabiting the bodies of mammals and insects provide their hosts with an endogenous source of these vitamins. There is evidence that even in man B-vitamins are produced by bacteria in the colon. Further investigations will probably greatly extend the list of animals with such an endogenous symbiotic supply of B-vitamins.

Some of the results of recent investigations of the symbiotic relations of micro-organisms and mammals have been discussed elsewhere[35,36].

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OBITUARIES

Dr. D. E. Lea

RADIOBIOLOGY has suffered a serious loss by the death of Douglas Lea as the result of an accident at the early age of thirty-seven. In his short life he had already become one of the leading authorities in the world on the fundamental aspects of the mechanism of the biological actions of ionizing radiations. Fortunately, he had summarized his work and ideas in an excellent book entitled "Actions of Radiations on Living Cells" (Cambridge University Press, 1946). This book is his memorial and is likely to influence radiobiology and radiotherapeutics for many years to come.

Douglas Edward Lea was born in Liverpool on February 8, 1910. From Liverpool Collegiate School he went with scholarships to Trinity College, Cambridge, in 1928. He gained firsts in Part 1 of the Mathematical Tripos in 1929, and in Part 2 (Physics) of the Natural Sciences Tripos in 1931. The whole of his working life was spent in Cambridge. He started research in physics, working in the Cavendish Laboratory with Lord Rutherford and Dr. (now Sir James) Chadwick. In 1934 he made the discovery of the capture of a neutron by a proton to form a deuterium nucleus with emission of gamma radiation. For this and related work he was elected to a fellowship at Trinity in 1934. He took the degree of Ph.D. (Cambridge) in 1935. Then he turned to biophysics, and went to work at the Strangeways Laboratory, first with a grant from the British Empire Cancer Campaign and then during 1942–46 as Prophit Student of the Royal College of Surgeons. His first work in this field was a study of the mechanism of the bactericidal action of radiations, made in conjunction with his friends Drs. R. B. Haines and C. A. Coulson, and was a promising beginning, with quantitative interpretation of the results in terms of the target theory. Although twenty-one out of his thirty-one biological papers were published in collaboration, it is evident that in many of them Lea made a major contribution both to the experimental technique and the quantitative interpretation. His experimental skill, developed during his period of training at the Cavendish Laboratory, is demonstrated in his papers on a radiation dosemeter and automatic devices for controlling the output of X-ray tubes, and the X-ray equipment he built at the Strangeways Laboratory. He went to great pains to learn the necessary biological techniques, as shown, for example, in his paper on the delayed lethal action of radiations on chick embryos.

Lea's outstanding contributions to radiobiology are to be found in his papers on the target theory of gene mutation, the variation with wave-length of the biological effects of radiations, the inactivation of viruses and enzymes by radiations and the mechanism of induction of chromosome aberrations by radiations. Of great interest and importance was his work in collaboration with Dr. D. G. Catcheside on chromosome aberrations in *Tradescantia*, in which was made the remarkable theoretical prediction, with experimental verification, of the sharp maximum in efficiency of chromatid breakage by soft X-rays at a wave-length between 4 and 5 A.

During the last few years Lea was becoming increasingly interested in the mechanism of radiochemical reactions in relation to biological effects. In October 1946 he was appointed reader in radiobiology in the Department of Radiotherapeutics of the University of Cambridge, though on account of the shortage of laboratory space he continued to work at the Strangeways Laboratory. Only two days before his death he was informed that he had been successful in his application for the degree of Sc.D. of the University of Cambridge. He had many plans, and had arranged to take leave of absence during the next academic year to work at the Memorial Hospital in New York.

Lea had come to occupy an exceptional position as collaborator, adviser and friend to a great many workers in a wide range of subjects requiring the application of biophysical, statistical and mathematical techniques. We all liked him for his unending kindness, his integrity, his modesty and his patient helpfulness. He always produced the information required, without considering time or trouble. It is very difficult to estimate the extent of his influence. Although it could be said that his work was his main interest, he was also essentially a family man, and greatly devoted to his wife and two young children.

J. S. MITCHELL

K. H. Stephensen

AFTER a short illness from pneumonia Knud Hensch Stephensen, inspector of the University Zoological Museum of Copenhagen, died on March 13.

Stephensen was born on November 29, 1882, and took his degree as *candidatus magisterii* at the University of Copenhagen in 1907. Besides teaching at a grammar school, he at once embarked upon the study of crustaceans, which held his interest for the rest of his life. From 1914 he was curator of the crustacean collections of the University Zoological Museum and was thus the successor of H. J. Hansen and, before him, Henrik Kröyer; under his care, the collections were kept in excellent order and grew considerably. At the same time he was a very productive investigator, the total number of his papers being about 130; practically all of them deal with crustaceans and pycnogonids.

Stephensen's work was primarily systematic and faunistic, and he seldom attempted to draw general conclusions of a higher order; but all his papers bear witness to his deep penetration into his subject; he was a capable draughtsman, and had a thorough knowledge of the literature of the Crustacea. He dealt with almost all groups of the Malacostraca, and was one of the few systematicists left who really mastered this big group. But even he had to realize the necessity of specialization; and he chose one of the most difficult and largest groups, the amphipods. A long series of papers appeared on the North Atlantic species, benthonic as well as planktonic; big reports on the collections of the *Ingolf* and the *Thor* Expeditions were followed by papers on collections from almost every part of the world. At his death he was undoubtedly the leading authority on the systematics of amphipods. Yet one of his last papers—and an excellent one—was on the crabs of the Persian Gulf.

Stephensen led a happy life; he was enthusiastic about his work, whether sitting quietly at the microscope in the museum or collecting in the field. In 1912 he spent the summer in West Greenland studying the fauna of the fjords; during 1921–22 he took part in the *Dana* Expedition to the Sargasso Sea, West Indies and the Gulf of Panama, and in 1925 he collected in the Faroe Islands.

While his publications show him mainly as a carcinologist, Stephensen's general interests were wide; he was a keen all-round naturalist and also much interested in architecture and archæology. Many colleagues all over the world will miss his long and personal letters, written in his beautiful handwriting —colleagues who became his friends for life, if they happened to visit Copenhagen and once experienced the friendliness and hospitality of Stephensen and his wife.

Stephensen considered a sound taxonomy of fundamental importance to all branches of biology, ecology, physiology, etc., a view which has not been sufficiently appreciated by many working in these fields; so much the greater was his pleasure when, in 1946, he was made a corresponding member of the Linnean Society of London, for he took it as a token that his work on the lines of Linnæus, whom he admired very much, had not been in vain.

Every empty chair in the field of zoological systematics is difficult to fill nowadays, and Stephensen's death means a great loss to Danish zoology; but his authority will be missed beyond the borders of his own country.

ANTON FR. BRUUN

NEWS and VIEWS

Theoretical Physics at Manchester: Prof. L. Rosenfeld

DR. LEON ROSENFELD has now taken up the position, to which he was recently appointed, of professor of theoretical physics in the University of Manchester in succession to Prof. D. R. Hartree. Prof. Rosenfeld was born in 1904 in Liège, graduating there in 1926. He then spent a year in Paris at the École Normale Supérieure, during which he worked with Prof. Louis de Broglie. His first published work, on five-dimensional relativity, appeared about this time. In 1927 he went as assistant to Prof. Max Born in Göttingen, and while there worked on problems of optical activity and the Faraday effect; then to Zurich with Prof. Pauli, where he studied quantum electrodynamics. In 1931 he became a teacher in the School of Electrical Engineering at Liège. From 1930 until 1940 he worked in very close collaboration with Prof. Niels Bohr, spending a considerable part of each year in Copenhagen. In 1935 he was elected to the chair of theoretical physics at Liège, and in 1940 moved to a similar chair at Utrecht in Holland. Prof. Rosenfeld is one of the leading theoretical physicists of to-day and is distinguished not only for his great original contributions to the most difficult and deep parts of modern quantum mechanics and nuclear structure, but also for his wide knowledge and scholarship. He is now completing a book on the quantum theory of nuclear forces which should prove valuable to all theoretical workers on nuclear structure. In his new position in Manchester he will add greatly to the strength of theoretical physics in England. He will be in very close touch with the experimental researches being carried out in the laboratory of Prof. P. M. S. Blackett.

Case Institute of Technology: Dr. T. K. Glennan

DR. T. KEITH GLENNAN, now an executive of the Ansco Division of General Aniline & Film Corporation, Binghamton, New York, and war-time director of the U.S. Navy Underwater Sound Laboratory, has been appointed president of the Case Institute of Technology. Dr. Glennan will be the first business executive to head the Cleveland engineering school, which has had but three presidents since its establishment sixty-seven years ago as the Case School of Applied Science and which adopted its new name on July 1. He succeeds Dr. William E. Wickenden, who retires on September 1, after eighteen years of service.

Dr. Glennan received the Medal for Merit, the highest civilian award which the U.S. Government can bestow, for his work during 1942–45 at the U.S. Navy Underwater Sound Laboratory, which was operated by Columbia University at New London, Conn., for the Office of Scientific Research and Development, headed by Dr. Vannevar Bush. As director of this laboratory he guided the development of various submarine detection and location devices. One of these, the expendable radio sono-buoy, is described in James Phinney Baxter's Pulitzer prize volume, "Scientists Against Time", as "one of the outstanding developments of the war". This device led to the destruction of a large number of German submarines and played an important part in the Battle of the Atlantic.

Electrical Engineering in the University of Alberta: Prof. J. A. Harle

MR. J. A. HARLE, head of the Technical and Research Department of Messrs. A. Reyrolle & Co., Ltd., has been appointed professor of electrical engineering in the University of Alberta at Edmonton, Canada, and is sailing early in August to take up his appointment on September 1. He served his time with Messrs. C. A. Parsons and Co., Ltd., and studied at Armstrong (now King's) College under the late Prof. W. M. Thornton, graduating with distinction in 1919. He was appointed lecturer in electrical engineering at Armstrong College in the same year. In 1922 the late Mr. Clothier invited him to join the Technical and Research Department of Messrs. A. Reyrolle & Co., Ltd., and he took over the headship of the Department in 1937, when he succeeded Mr. B. H. Leeson. Mr. Harle served as chairman of the North-Eastern Centre of the Institution of Electrical Engineers during the session 1944–45, and he has been the Institution's area member for the Education and Training Advisory Service for returned Service members. He is particularly interested in insulation and circuit-breaking problems, both from the research and from the standardization point of view.

Genetical Society of Great Britain: Honorary Members

AT the annual general meeting of the Genetical Society of Great Britain, held at Rothamsted Experimental Station, Harpenden, on July 3, the following were elected honorary members of the Society: Prof. Herman Joseph Muller, Department of Zoology, Indiana University, Bloomington, Ind., who has played a leading part in the analysis of the genetics of *Drosophila*, and is known especially for work on the induction of mutation by X-rays, which he initiated and developed; Prof. Otto Renner, Department of Botany, University, Jena, known for his analysis of the genetics of *Oenothera*, by which he solved a problem which had exercised evolutionists for twenty-five years, and also for his outstanding work on the autonomy of plastids; Prof. Øjvind Winge, Carlsberg Laboratorium, Copenhagen, distinguished for his studies on the sex chromosomes, especially of fish and of flowering plants, by which he successfully demonstrated the evolution of the XX-, XY-chromosome mechanism, also for his distinguished researches on the genetics of wheat and of the ever-sporting stock (*Matthiola*).

International Union of Crystallography

AT an international conference of crystallographers held in London in July 1946 under the auspices of the X-ray Analysis Group of the Institute of Physics (*Nature*, 158, 260 (1946); *J. Sci. Instr.*, 24, 1 (1947)) a committee was appointed to prepare a permanent international organisation of crystallographers. This task has now been achieved, and an International Union of Crystallography has been formed and recognized by the International Council of Scientific Unions. In the countries adhering to the Union, national crystallographic committees will be set up. Among the purposes of the new Union listed in the statutes are the promotion of international co-operation and publication, and the representation of crystallography in its relations to other sciences. The first full constitutive general assembly may be delayed for a year or two, until a full-scale international gathering becomes desirable after the meeting in 1946; but the committee charged with preparing the formation of the Union has been authorized to carry on meanwhile as the executive committee. The acting general secretary is Dr. R. C. Evans, Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England, to whom all correspondence should be directed.

Acta Crystallographica

The most urgent task confronting the new Union of Crystallography is the re-establishment of an international journal for publishing crystallographic research. Thanks to generous financial support from the United Nations Educational, Cultural and Scientific Organisation and from many research associations and industrial organisations in Britain, preparations are now well advanced for the launching in January 1948 of *Acta Crystallographica*, a journal to appear in six issues a year under the editorship of Prof. P. P. Ewald (Queen's University, Belfast, Northern Ireland), with Dr. R. C. Evans (Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England), Prof. I. Fankuchen (Brooklyn Polytechnic Institute, 99 Livingston Street, Brooklyn 2, N.Y., U.S.A.), Prof. A. V. Shubnikov (c/o Academy of Sciences, Moscow, U.S.S.R.) and Prof. J. Wyart (Laboratoire de Minéralogie, La Sorbonne, 1 rue Victor-Cousin, Paris V, France) as regional co-editors. The Cambridge University Press will be the publishers and general distributors; but by arrangement of the American Institute of Physics it will be possible for subscribers in North America to pay their subscription through that Institute. Authors wishing to submit papers in English, French, German or Russian are asked to send them to Dr. Evans or Prof. Fankuchen, Prof. Wyart, Prof. Ewald, and Prof. Shubnikov, respectively, according to the language used.

Council for the Promotion of Field Studies

The Council for the Promotion of Field Studies announces that it has gratefully accepted the generous offer of the Court of the Worshipful Company of Goldsmiths to provide the sum of £6,000 for the establishment of a residential field study and research centre at Malham Tarn House, near Settle, Yorkshire. It is desired that the gift should be associated in name with the Goldsmiths' Company, and that a portion of it should be used to set up a rock and water garden for plants in their natural setting. Last year this property of 457 acres, including the tarn and tarn moss, came into possession of the National Trust, which offered to lease it to the Council. Malham Tarn House is situated in a district of great geological, ecological and archæological interest, and for certain branches of study the position of this field centre will be unique in the British Isles.

The Carnegie United Kingdom Trust, through the generosity of which the Council was enabled to open its pioneer field centre at Flatford Mill in 1946, has recently made a further grant of £5,000 to complete the establishment of that centre. Further centres are being established at Juniper Hall, near Box Hill, Surrey, and at Dale Fort, on the Pembrokeshire coast.

Prof. A. G. Tansley has accepted the office of president of the Council, and the executive committee has made the following appointments: Director and Secretary: F. H. C. Butler, Ravensmead, Keston, Kent; Warden of Flatford Mill Field Centre: E. A. R. Ennion; Warden of Juniper Hall Field Centre: G. E. Hutchings; Assistant Wardens: J. H. Barrett, E. J. Douglas, J. H. P. Sankey. A central office for the Council will be opened shortly in South Kensington.

Bradford Technical College

The application of the Bradford City Council to the University Grants Committee for the recognition of Bradford Technical College as a university college ranking for a Treasury grant has been refused. In communicating this decision, the University Grants Committee has stated that it considers the application of the term 'university college' to an institution primarily or exclusively technological in scope to be inappropriate and confusing; the distinction is not one of rank or status, but of kind. The Committee also pointed out that financial support for a college of which the primary function is technology is a matter for the Ministry of Education and not for the University Grants Committee. Following consideration of the report of the University Grants Committee at a meeting on June 18, Bradford Further Education Sub-Committee decided to seek an interview with both the Chancellor of the Exchequer and the Minister of Education to investigate further the possibilities of securing for the College university status.

"A Century of British Chemistry"

We have received "A Century of British Chemistry", by Dr. F. Sherwood Taylor, published for the British Council by Longmans, Green and Co., Ltd. (1*s*. 6*d*. net). This is intended to mark the centenary celebrations of the Chemical Society, which were due in 1941 but were postponed on account of the War (see *Nature* of July 5, p. 6). The booklet deals with the contributions of British men of science to various branches of chemistry during the century in which the Society has been in existence; but as no historically sound document could be produced on such lines alone, account has also been taken in some places of the contributions of other nations in initiating or extending chemical knowledge. The booklet includes plates of portraits and illustrations of apparatus of historical interest. There is an index.

History of Chemistry

The University of Pennsylvania Press is initiating an annual publication on the history of chemistry, entitled *Chymia*. A volume will consist of about a dozen articles, each of about 4,000–5,000 words, contributed by outstanding scholars from all over the world. The publication is sponsored by the Edgar F. Smith Memorial Collection at the University of Pennsylvania, a well-known collection of rare books, manuscripts, prints, and other items of interest in the development of chemistry. Publication will be under the direction of a board of American editors with a group of consulting editors, all of international prominence. The first number is ready for the press and will probably be issued this autumn. The Oxford University Press will publish *Chymia* in Great Britain. Requests for further information should be addressed to Eva V. Armstrong, secretary of the Board of Editors, Edgar F. Smith Collection, Harrison Laboratory, University of Pennsylvania, Philadelphia 4.

Non-industrial Civil Servants

In the detailed statement as to the number of non-industrial Civil Servants in departments with staffs of more than a thousand at April 1, 1947, circulated by the Chancellor of the Exchequer in *Hansard* of July 1 in reply to a question in the House of Commons, the staff of the Department of Scientific and Industrial Research is given as 2,248, as against 1,502 on April 1, 1939. The Forestry Commission now employs 1,334 as against 509, the Ministry of Agriculture and Fisheries 6,233 instead of 2,591, the Ministry of Education 2,898 instead of 2,078, the Ministry of Health 5,087 as against 6,676, the Department of Agriculture, Scotland, 1,376 instead of 659, and the Department of Health, Scotland, 1,013 in place of 991. The total is now 702,363 as against 382,709 in 1939; of this number 262,372 are in the Post Office. In the debate on the Post Office on the following day some reference was made to research, and the Assistant Postmaster-General stated that a house has been taken at Stone, Staffordshire, where a thousand engineers would be trained, some of whom have been at Dollis Hill. The accommodation thus released would be available for carrying out fundamental research, and by 1950 it is expected to have 150 fully qualified scientific men and engineers on such research. It is proposed to double the major engineering and scientific staff at Dollis Hill during the next few years.

Imperial Bureau of Pastures and Field Crops

As a result of a recommendation of the 1946 Review Conference of the Imperial Agricultural Bureaux, the Imperial Bureau of Pastures and Forage Crops now becomes the Imperial Bureau of Pastures and Field Crops (director, Dr. R. O. Whyte). In its expanded form it will cover that part of the literature on the following crops not already the concern of the Bureaux of Plant Breeding and Genetics, or Soil Science: all cereals, field root-crops, pulses, groundnuts, cotton and other fibre crops grown on a field scale, sugar beet and sugar cane, in addition to the literature on grassland management and fodder production which has been the concern of the Bureau for the past seventeen years. Attention will continue to be given to those aspects of plant biological research which refer to the crops now covered, and sections will now also deal with farming systems concerned in the production of field or forage crops, and certain economic aspects of crop and fodder production.

Although the name of the Bureau has been changed to Pastures and Field Crops and a second abstracting journal (in addition to *Herbage Abstracts*) is to be published from 1948 onwards, it will be some time before it will be possible to claim that the extended field of research and practice is being adequately covered, or before it will be possible to reply without a little difficulty to inquiries on the new crops now added to the Bureau's responsibilities. Those concerned with these crops should send their publications and reports to the Imperial Bureau of Pastures and Field Crops, Penglais, Aberystwyth, Wales, for review in the new abstracting journal dealing with field crops. Particulars of this journal will be sent to persons interested.

University of Birmingham

The University of Birmingham has created a chair of gastroenterology and has appointed as its first occupant Dr. T. L. Hardy. Dr. Hardy was one of the founders of the British Society of Gastro-enterologists in 1938.

Dr. J. F. Brailsford, who is well known as a radiologist, has been appointed honorary director of radiological studies in living anatomy. Dr. Brailsford was the first radiologist to be elected Hunterian professor of the Royal College of Surgeons, and is a former president of the British Association of Radiologists.

Four members of the University have been appointed to professorial chairs overseas: Dr. F. Smith, reader in the Department of Chemistry, to the chair of chemistry in the University of Minnesota; Mr. N. M. MacElwee, lecturer in electrical engineering, to the chair of electrical engineering in University College, Christchurch, N.Z.; Dr. T. G. Hunter, of the Chemical Engineering Department, to the chair of chemical engineering in the University of Sydney, Australia; and Dr. F. J. Llewellyn to the chair of chemistry in the University of Auckland, N.Z.

At the annual degree congregation, the Chancellor (Mr. Anthony Eden) conferred the honorary degree of doctor of science on Dr. Otto Robert Frisch, director of the Nuclear Physics Section of the Atomic Energy Research Establishment at Harwell, newly appointed Jacksonian professor of natural philosophy in the University of Cambridge. The degree of doctor of science was conferred on the following: F. A. Fox (metallurgy), J. K. N. Jones (chemistry), J. H. Partridge (metallurgy), W. T. Pell-Walpole (metallurgy), and L. F. Wiggins (chemistry).

A presentation was made to Prof. J. G. Smith, after twenty-eight years service to the University, on his retirement from the post of vice-principal. Prof. Smith is succeeded as vice-principal by Sir Norman Haworth, professor of chemistry in the University.

Announcements

In connexion with the centenary celebrations of the Chemical Society, the University of London has conferred honorary degrees on the following: Prof. C. N. Hinshelwood, Dr. Lee's professor of chemistry in the University of Oxford (president of the Chemical Society); Prof. J. N. Brønsted, professor of chemistry in the University of Copenhagen; Prof. P. Karrer, professor of chemistry in the University of Zurich; Prof. L. C. Pauling, professor of chemistry in the California Institute of Technology.

Prof. G. H. Hardy, emeritus professor of pure mathematics in the University of Cambridge, and Dr. A. F. Blakeslee, honorary professor of botany at Smith College, Northampton, Mass., have been elected foreign associates of the Paris Academy of Sciences.

Sir Edward Appleton, Sir Alexander Fleming and Sir Arthur MacNalty have been elected honorary fellows of the Royal Society of Edinburgh.

Dr. David Heron has been elected president of the Royal Statistical Society in succession to Lord Woolton. Prof. J. H. Jones, emeritus professor of economics in the University of Leeds, has been elected honorary treasurer.

The following appointments in the University of Sheffield have been announced: Dr. D. H. Peacock, lecturer in chemistry; C. Hulse, lecturer in fuel technology; H. D. Bush, assistant lecturer in physics; J. M. Thoday, assistant lecturer in botany and zoology (for cytogenetics); Dr. D. B. Leason, research assistant in fuel technology. Dr. R. Rado has resigned from the post of lecturer in mathematics.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Quantitative Estimation of Mixtures of Sugars by the Paper Chromatogram Method

MODERN developments in the chemistry of the polysaccharides have served to increase the importance of the problems of identification and estimation of mixtures of sugars. In many cases the mixture of sugars resulting from hydrolysis of a polysaccharide is so complex as to render analysis by orthodox methods difficult. These have depended mainly on precipitation by a specific reagent and deal usually with quantities of the order of 200 mgm. of each individual sugar. There is an urgent need, therefore, for a method which would permit separation and facile estimation of complex mixtures, and would be capable of dealing with the very small quantities which are obtained in many biological studies.

A remarkable advance on the qualitative side has recently been described by Partridge[1], who has developed an application of the paper chromatogram[2] to the separation of exceedingly minute amounts of sugars. Using a similar technique, we have now elaborated a method for the quantitative determination of the separated sugars, and we are able to analyse qualitatively and quantitatively mixtures containing several sugars with an accuracy of ± 5 per cent. The total quantity of material used in the analysis is less than 1 mgm.

For the quantitative estimation of the sugars separated on the chromatogram, Somogyi's micro-copper reagent[3] has been used. An alternative procedure consists of measuring by a colorimetric method[4] the formaldehyde produced by oxidation of the sugars with periodic acid. The micro-copper reagent will deal with quantities of sugar ranging from about 0·05 mgm. to 5·0 mgm., these amounts varying slightly with different sugars. In order to obtain amounts of sugar on the paper chromatogram falling within this range, as many drops of solution (of equal size) as are required to make up this quantity are placed side by side on the starting line of the chromatogram. In general, two paper sheets were used, measuring approximately 60 cm. by 10 cm. One of the end spots is well separated from the others, so that after chromatographing and drying off the solvent, a narrow strip containing this end spot can be cut from the original paper sheet and the position of the sugars determined by spraying with ammoniacal silver nitrate, a preliminary qualitative identification of the sugars having already been made on another chromatogram. The rest of the paper can then be divided into corresponding sugar zones by reference to the small sprayed strip. At the same time, equal areas of paper are cut from the same major sheet to serve as paper blanks.

After the sheet has been cut, the strip of paper containing the sugar is suspended by platinum wire from the lower coil of a ground-glass spiral condenser to which is attached by a ground-glass joint a boiling-tube containing water. All further operations are carried out in this tube, so that no transfer of liquid is necessary. It has been found that the sugars can be extracted quantitatively by refluxing water in this apparatus. At the same time, an exactly identical procedure was carried out with the appropriate paper blank.

In order to obtain consistent results with the copper reagent, it was found essential to analyse at the same time a standard solution of the particular sugar under identical conditions. By this means it is possible to arrive at a sugar-weight corresponding to each titration figure, and in this way the sugar ratios can be determined.

In some cases where it is known with certainty that the sugars determined comprise the sum total of polysaccharide, it is sufficient to convert the ratios to percentages. More often, however, partially hydrolysed components may be present which would make this device unjustifiable. This difficulty is readily surmounted by weighing into the hydrolysate a sugar known not to be originally present and having a R_F value markedly different from the sugars to be estimated. This serves as a reference compound, and a knowledge of the various ratios now leads directly to absolute weights.

For example, using this procedure we have been able to estimate satisfactorily the components present in a mixture containing respectively galactose and rhamnose; glucose, xylose and arabinose; and galactose and arabinose. These groups were chosen specially on the ground that they are of frequent occurrence in plant gums and other similar materials, and offer very serious analytical problems by ordinary methods. As a particular example of a difficult mixture, results obtained with rhamnose and arabinose are given in detail in the accompanying table.

		Sugar weighed out (mgm.)	Found by titration (mgm.)	Calculated from reference compound (mgm.)	Recovery (per cent)
To be estimated	Rhamnose	9·60	0·261	9·22	96
To be estimated	Arabinose	5·80	0·157	5·54	95·5
Reference compound	Glucose	4·38	0·124	—	100 (assumed)

As a further example of the scope of the method, reference may be made to its application to an analysis of the sugars present in Cholla gum (from *Opuntia fulgida*). Qualitative chromatographic analyses revealed the presence of *l*-arabinose, *d*-xylose, *d*-galactose and a uronic acid. Quantitative chromatographic analysis, together with an estimation of the uronic acid content by a micro-method, showed that the sugars and uronic acid are present in the polysaccharide in the ratio of 6 : 2 : 3 : 1 respectively. Investigations by Mr. Fred Brown using the normal procedure of methylation and hydrolysis on the macro-scale had earlier revealed the same proportion of sugars to be present in the gum.

Furthermore, we have succeeded in separating mixtures of methylated sugars and are applying the method to end-group determinations on a micro-scale. Using petrol ether, b.p. 40°–60° (specially purified), as the mobile phase in the chromatogram, it is possible to separate a dimethyl pentose from a trimethyl pentose, while *n*-butanol permits the separation of a trimethyl hexose from a tetramethyl hexose. The sugars can be isolated and estimated as before, except that in these cases the periodate-formaldehyde method is not applicable.

The qualitative separation has also been made applicable to the simple mono- and di-carboxylic acids and is being extended to cover the sugar acids.

It is apparent that the method should be of wide application as a micro-method of investigation in the carbohydrate group.

A. E. Flood
E. L. Hirst
J. K. N. Jones

Department of Chemistry,
University,
Manchester, 13.
May 3.

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[1] Partridge, S. M., *Nature*, 158, 270 (1946).

[2] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, 38, 224 (1944).

[3] Somogyi, M., *J. Biol. Chem.*, 160, 61 (1945).

[4] Desnuelle, P., Antonin, S., and Naudet, M., *Bl. Soc. Chim. biol. (Trav.)*, 26, 1168 (1944).

Colour of Iodine Solutions

The dependence of the colour of iodine solutions upon the nature of the solvent is generally believed to be due to the presence of loosely bound iodine-solvent complexes, or 'solvates', in the brown solutions (for example, in ethanol) and of 'unsolvated' diatomic iodine molecules in the violet solutions (for example, in carbon tetrachloride)[1]. The nature, however, of this 'solvation' remains obscure. It is obviously not a simple electrostatic solvation, for it has little to do with the dielectric constant of the solvent; nor would such a solvation serve to account for the marked difference in chemical properties between the violet and brown solutions.

An explanation may be found in the amphoteric nature of iodine. There is some evidence to show that the symmetrical ionic structures $Hal^+.Hal^-$; $Hal^-.Hal^+$ may contribute more to the actual normal state of the halogen bond, especially in bromine, and still more in iodine, than has been commonly supposed. Moreover, since the univalent positive iodine ion contains an unoccupied $5p$ orbital in the free state, the proximity of an electron-donor, for example, an oxygen, sulphur or basic nitrogen compound, would stabilize one of the ionic structures and thus destroy the electrical symmetry of such an iodine molecule, bringing about what is, in effect, a partial ionization of the iodine, with the positive end of the molecule stabilized by co-ordination with the donor molecule. The essential difference, therefore, between a violet solution and a brown one is that whereas in the former the iodine is present as symmetrical non-polar diatomic molecules, in the latter the iodine molecules are polarized by co-ordination with an electron donor molecule.

That it is principally the electron-donor character of the solvent and not its dipolar character which is operative is shown by the fact that iodine forms brown solutions in very weakly polar solvents which have some donor character, but violet solutions in such strongly polar solvents as nitro-compounds, which have little or no donor or 'basic' properties.

This theory is supported by the magnitude of the dielectric polarization of iodine in violet and brown solutions respectively. A new series of measurements has been made, and is being extended, of the dielectric polarization of iodine in a number of solvents of small or zero polarity and in the presence of electron-donor groups. The results, details of which will be published in due course, leave no doubt that the formation of a red or brown solution of iodine is accompanied by a polarization of the molecule. For example (to the nearest $0 \cdot 1\ D$), the *apparent* dipole moment of iodine in benzene (reddish-violet solution at 25°) is $0 \cdot 6\ D$, in *p*-xylene (deeper red), $0 \cdot 9\ D$, in 1 : 4-dioxane (brown), $1 \cdot 3\ D$, and in di-isobutylene (red-brown solution), $1 \cdot 5\ D$.

No less interesting, however, than this solvolytic ionization of iodine itself is the light which it throws on the donor or basic properties of aromatic and ethylenic hydrocarbons.

A similar explanation to that offered above may without doubt serve also to account for the parallel phenomena of the dichroism observed in solutions of iodine monochloride and iodine monobromide[2,3].

F. Fairbrother

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May 20.

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[1] Lachmann, *J. Amer. Chem. Soc.*, 25, 50 (1903).

[2] Gillam and Morton, *Proc. Roy. Soc.*, A, 132, 152 (1931).

[3] Gillam, *Trans. Farad. Soc.*, 29, 1132 (1933).

Partition Chromatography of Organic Acids on a Paper Sheet Support

By so-called 'one-dimension partition chromatography' on a paper support (first used successfully by Consden, Gordon and Martin[1] for the separation of amino-acids, and recently adapted by Partridge[2] for the separation of reducing sugars), we have succeeded in separating the individual members of a mixture of carboxylic acids of the types commonly occurring in plant tissues.

Attempts to exploit this sort of procedure, with water as the fixed phase in the paper and a neutral mobile phase (*n*-butanol), were unsuccessful for the following reasons. (*a*) From the positions at which the 'spots' of aqueous solutions of the individual acids were applied to the paper, the acids left long, diffuse 'tails' behind the 'heads' as the heads travelled down the paper with the mobile phase; and, moreover, (*b*) the excursions of the heads were found to vary with the concentrations of the acids, being less at the lower concentrations. The diffuse tails made it impossible to separate the members of a mixture, and the variation of excursion with concentration precluded the possibility of identifying an acid by the excursion of its head relative to the excursion of the mobile phase.

Under the above conditions of experimentation, it is possible that the acids are adsorbed to some extent by the paper. Be that as it may, a serious difficulty must, in any event, arise from the increase in dilution of an acid in the neighbourhood of the initial spot as it is withdrawn therefrom into the mobile phase for transmission down the paper. From consideration of the dielectric constants of water and of *n*-butanol, it is reasonable to suppose that the 'gross' partition of an acid between the aqueous and the mobile phase will change markedly in favour of the aqueous phase as dilution proceeds. The diffuse tails and the reduction in extent of excursion with reduced concentration of the acids in the applied spots are, therefore, to be expected, even if adsorption of the acids by the paper is not an important factor.

One method of overcoming the difficulty is to use, as mobile phase, a solvent strongly acidified with a volatile acid. The mobile phase (we have used *n*-butanol saturated with aqueous acetic acid solution, and containing 1 or 2 moles of acetic acid per litre of the phase) may be removed afterwards, together with much of the aqueous phase, by exposing the paper sheets to the air for many hours or by drawing over them in a drying cabinet a current of warm air (up to 60° C.) for an hour or so. We prefer to remove most of the volatile material by a brief run in the cabinet, and complete the removal by exposing the sheets to air at room temperature for several hours.

We spray the dried sheets with a suitable *p*H indicator solution and then re-dry them. A solution of 40 mgm. of brom-phenol-blue (or of brom-cresol-green) in a mixture of 95 ml. of ethanol and 5 ml. of water and adjusted to a purple tint corresponding with *p*H 5·0 in water (or blue with the second indicator) corresponding with *p*H 5·5 in water) is satisfactory for most purposes. The positions of the individual acids are then revealed by yellow spots on a purplish-blue (or greenish-blue with the second indicator) ground.

The spots have slight tails but are reasonably well defined. The R_F values (that is, the ratios of the excursions of the spots from the initial positions, to that of the front of the mobile phase from the same positions) appear to decrease slightly with decrease of concentration of the acids.

By excising the areas of paper enclosing the spots, steeping in water and titrating with dilute alkali between selected *p*H values, we have obtained rough estimates of the quantities of the acids in the solutions initially applied. Blanks are determined on excised areas of paper (over which the mobile phase has run) which are free from the spots.

The aqueous phase is established in the paper by exposing it in the chromatography tank to vapour from the aqueous volatile acid solution which has been used to saturate the mobile phase. The mobile phase is run over the paper from a trough in the manner described by Consden, Gordon and Martin[1] (that is, by capillarity). We have used Whatman No. 1 filter papers (22 in. × 18 in.). The volumes of acid solutions applied as initial spots have been 0·02 ml. Mixtures of 20 μgm., each of malic, tartaric and citric acids, have been resolved with ease. The period of a chromatographic run has varied from 18 to 40 hours, at about 17° C.

In our view, the essential chromatography problem was to suppress the ionizations of the acids in both phases, particularly in the fixed phase wherein (water comprising most of the phase) they would be extensive at low concentrations in the absence of a high concentration of hydrogen ions from another source. Whether adsorption of the acids by the paper constituted a serious problem in our initial experiments, we do not know. This problem, to whatever extent it may have existed, was probably solved jointly with the ionization problem, at least to the present state of satisfaction, by 'swamping' with the volatile acid.

A limitation to this application of partition chromatography is imposed by the fact that the acids concerned in the study should be of sufficiently low volatility to remain on the paper during exposure in the chromatography tank and during the subsequent removal of the volatile acid.

Work is proceeding with organic acids of general interest in plant and animal metabolism, on the use of other mobile phase solvents and formic acid as the volatile acid, and on 'two-dimension' partition-chromatographic[1] separations. It is our intention to publish a more detailed report of the work later.

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April 19.

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[1] Consden, Gordon and Martin, *Biochem. J.*, 38, 224 (1944).

[2] Partridge, *Nature*, 158, 270 (1946).

Mercurochrome as an Indicator in Acid–Alkali Titrations

It has been found that, in an alkaline solution, mercurochrome (disodium-dibromo-hydroxy mercury fluorescein) exhibits fluorescence which disappears as soon as the solution reaches the neutralization point during its titration with an acid. It then becomes markedly red as the solution becomes acid, there being now no fluorescence.

This change was equally clearly marked in the case of natural waters even with low alkalinity, and the results were identical with those obtained when methyl orange was used as an indicator. When solutions of potassium hydroxide, sodium carbonate or sodium bicarbonate were titrated against a standard acid, the use of mercurochrome as an indicator gave exactly the same results as methyl orange.

Even when the titration of sodium carbonate with an acid was begun with phenolphthalein as an indicator and completed with mercurochrome, instead of methyl orange, the results were the same.

The same change in the reverse order was observed with equal exactness while passing from an acid solution, through the neutralization point to alkaline solution.

One drop of a 1 per cent aqueous solution of mercurochrome was employed throughout.

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March 1.

A New Colour Reaction for the D Vitamins

While making a comparative study of the colour reaction of steroids and triterpenes, we have found a hitherto undescribed reaction produced by the D vitamins, producing a clear and limpid blue colour which we think might be used for quantitative estimations. We carry out Pettenkofer's reaction for the biliary acids as follows: to 1–2 mgm. calciferol is added 1–2 mgm. saccharose, and the whole is dissolved completely in 1–2 c.c. of absolute ethanol. Then we add two drops of concentrated sulphuric acid, giving a red colour; then six drops of sulphuric acid are added, giving a stark blue colour. The test-tube is shaken to mix the two layers. The colour diffuses throughout the liquid, and the definitive colour is a pale limpid blue.

The intensity of the colour increases within the first fifteen minutes; thereafter it becomes stabilized as a sky-blue colour. The coloration obtained seems to be in a direct relation to the concentration, that is, according to Beer's law.

Ergosterin in similar conditions gives a clear violet colour.

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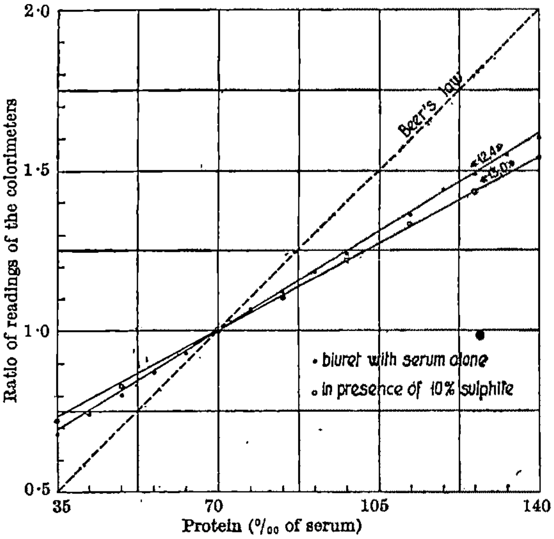
An Improved Biuret Reaction of Proteins and the Two-Standard Colorimetry

MEHL announced in 1945 [1] that by the use of ethylene glycol an alkaline copper reagent could be prepared in which copper, besides not being precipitated, could give the biuret reaction. At the high proportion in which glycol enters into Mehl's reagent, the presence of reducing impurities made it necessary to prepare the reagent in two stages, heating in order to speed up the reaction, and filtering in order to remove the precipitated copper. Nevertheless, the presence of the colour of the alkaline copper reagent causes the reaction to depart considerably from Beer's law; Mehl deduces from a spectrophotometric analysis that, starting from the 750 mμ and 545 mμ absorptions, the quantity of proteins present can be approximately calculated.

We have found that glycerine gives a better reagent for the biuret reaction than glycol, for the following reasons: the glycerine required is only a hundredth of the amount of glycol and there are no reducing impurities, thus making it possible to prepare the reagent in one stage.

This reagent is prepared by mixing 2 ml. of glycerin, 80 ml. of 5 per cent copper sulphate ($CuSO_4.5H_2O$) and 400 ml. of 20 per cent sodium hydroxide, and adding water up to 1 litre. This reagent is mixed, volume for volume, with the liquid under investigation (water being added if it is necessary in order to bring the final concentration of proteins to the value of about 1–2 °/₀₀).

As regards the colorimetric valuation, we have found that it is possible by visually compared colorimetry using our two-standard colorimetry system[2]; although theoretically it should not be possible, as it is an 'impurity' which varies according to the intensity of the reaction. It is interesting to note that the interference of sodium sulphite at half the concentration corresponding to the precipitation of globulins can also be removed by two-standard colorimetry.



The accompanying graph records two sets of experimental data giving serum proteins as parts per thousand of serum (the final concentration of the same being about 2 per cent). The slight deviations from the straight lines which represent particular cases in our general equation of compared colorimetry[3] do not prevent the practical determination of serum proteins. The increased deflexion caused by the sulphite comes fully into the field of utility of two-standard colorimetry.

A. SOLS

Instituto de Fisiología,
Facultad de Medicina,
Barcelona.
April 18.

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[1] Mehl, J. W., *J. Biol. Chem.*, 157, 173 (1945).

[2] Sols, A., *R. esp. Fisiol.*, 1, 355 (1945).

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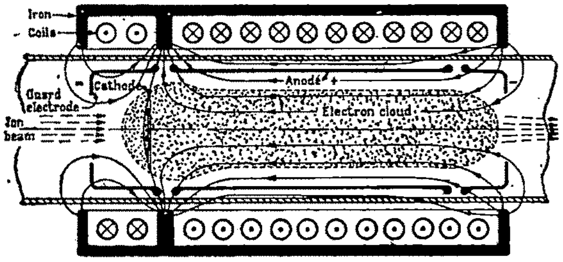
A Space-Charge Lens for the Focusing of Ion Beams

SOME time ago I proposed a magnetron of special design as a divergent lens for electron beams[1]. It now appears that the same device may become useful as a very powerful concentrating lens for positive ions, particularly for ion beams of extreme energy.



MAGNETRON LENS FOR ION BEAMS

In the design shown in the illustration, a magnetic field is produced by two coils of uneven length, in opposition. A hot cathode in the form of a circular loop is arranged at or near the magnetic field-line which crosses the axis. This arrangement is necessary, as electrons which have to cross magnetic flux lines are prevented by their angular momentum from reaching the axis. In the region where the magnetic field is approximately axial and homogeneous, a cylindrical electrode, the 'anode', is arranged, with high positive potential with respect to the cathode. So long as the anode potential is below a certain critical value, the magnetic field prevents all but a small fraction of the electrons from reaching the anode. At the two ends, guard electrodes with potentials somewhat below the cathode potential prevent the electrons from escaping. Thus the space accessible to electrons is limited from all sides, and will have an outline approximately as shown in the figure. Into this space the cathode will pour electrons, until the potential in the axis is depressed to very nearly cathode potential, and equilibrium is established.

According to the theories of Hull[2] and Brillouin[3], in the steady state the electrons rotate around the axis in equilibrium orbits, such that the electrostatic repulsion of the electrons inside the orbit together with the centrifugal force balance the radial Lorentz force produced by the magnetic field. The electron distribution in the cloud is uniform, with a space-charge density

$$\rho_H = -\frac{eH^2}{8\pi m_e c^2}, \qquad (1)$$

where $-e$ is the charge and m_e the rest mass of the electron. I have shown[1] that if the assumption of equilibrium orbits is valid, an electron shot axially through the magnetron will be also in radial equilibrium, that is to say, the lens effect is nil, apart from a relativistic effect. My previous suggestion, to use the magnetron as a divergent electron lens, was based on departures from the Hull–Brillouin steady state. Such departures were expected on the basis of my statistical theory of the electron cloud[4], in which radial equilibrium does not obtain at every instant but only over long intervals. It was pointed out at that time that neither the Hull–Brillouin theory, nor mine, is likely to apply under practical conditions, as both neglect electron interaction. But in the case of ion beams these differences can be disregarded, and equation 1 can be adopted, at least for a first orientation.

The radial forces of magnetic origin on ions of mass m_i are only a fraction m_e/m_i of the corresponding forces on an electron, and can be neglected compared with the radial electrostatic force, produced by the space charge, which retains its magnitude and merely changes its sign. The electric field intensity E_r at the radius r is

$$E_r = 2\pi r \rho_H = -\frac{eH^2}{4m_e c^2} r = -0{\cdot}044\, H^2 r \text{ volt/cm.} \quad (2)$$

The field is of the type required for lenses, as it increases linearly with the radius. Using the relativistic equation for the radial motion, the focal length f of a magnetron lens of length L is given by

$$\frac{1}{f} = 0{\cdot}022\,\frac{1 + 1{\cdot}06 \times 10^{-9} V/M}{1 + 0{\cdot}53 \times 10^{-9} V/M}\,\frac{H^2}{V}\,L \text{ cm.}^{-1}, \quad (3)$$

where V is the volt-energy of the ion, supposed to be single-charged, and M is its molecular weight.

As an example, consider a lens with $H = 500$ gauss and $L = 20$ cm., which requires about 8,000 amp. turns. If the radius of the anode cylinder is 2 cm. the critical voltage is 22 kV., and in practice perhaps 15 kV. may be applied before the anode current becomes noticeable. For 100 MeV. protons, that is, for $M = 1$, $V = 10^8$, equation 3 gives a focal length of 8·7 metres. By comparison, if the same coil were used, by itself, as a concentrating lens for 100 MeV. electrons, the focal length would be about 900 metres. The advantage is even greater at higher energies, as f in the new magnetron lens increases with V, as compared with V^2 for magnetic lenses and V^4 for electrostatic 'single' lenses. The only other lens types which share this advantage with the magnetron lens are the 'field lens' of L. W. Alvarez, in which the electric field terminates on a metal foil, its equivalent, recently investigated by me[5], in which the foil is replaced by a mesh grid, and the magnetic toroidal lens, recently proposed by W. T. Harris[6].

I thank the directors of the British Thomson-Houston Co., Ltd., for permission to publish this note.

D. Gabor

Research Laboratory,
British Thomson-Houston Co., Ltd.,
Rugby.
April 16.

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[1] Gabor, D., "The Electron Microscope" (Hulton Press, London, 1945).

[2] Hull, A. W., *Phys. Rev.*, 23, 112 (1924).

[3] Brillouin, L., *Phys. Rev.*, 60, 385 (1941).

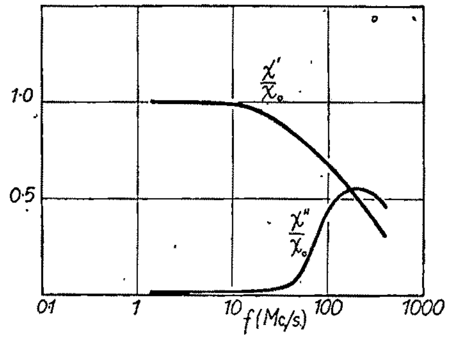
[4] Gabor, D., *Proc. Roy. Soc.*, A, 183, 436 (1945).

[5] Gabor, D., *Nature*, 159, 303 (1947).

[6] Harris, W. T., *Phys. Rev.*, 71, 310 (1947).

Gyromagnetic Resonance in Ferrites

Magnetic ferrites of great homogeneity have been prepared in this Laboratory. In these ferrites the tangent of the loss angle between B and H is found to rise at a certain frequency fairly suddenly from values less than 1 per cent to values much exceeding unity. The permeability at the same time goes down to very low values, which shows that not only the boundary displacements but also rotation of domains as a whole are affected at these frequencies. The behaviour of the complex susceptibility $\chi_c = \chi' - i\chi''$ (see graph) suggests a phenomenon of resonance.



According to calculations made by L. Landau and E. Lifshitz[1], gyromagnetic resonance may be expected to occur in a ferromagnetic dielectric, if the frequency of the applied field equals the precession frequency of the spins around the direction of the internal field. In Landau's model the specimen is assumed to be a single crystal and the applied field is at right angles to the crystal field. Our experiments, on the other hand, were carried out on polycrystalline samples. Nevertheless, it is worth while comparing Landau's formulæ and our experimental results.

Assuming that the precession is critically damped, one easily derives from Landau's equations the following relation between the transverse susceptibility χ_t, the frequency f_h, for which the real part of the susceptibility is halved, and the saturation magnetization $I_{\max}$:

$$\frac{\chi_t \cdot f_h}{I_{\max}} = \frac{\sqrt{2}}{2\pi} \cdot \frac{e}{mc} \cdot 4 \times 10^6 \text{ cycles/Oe. sec.}$$

Evaluation of χ_t, f_h and $I_{\max}$ for the polycrystalline sample, the properties of which are shown in the graph, leads to

$$\frac{\chi_t \cdot f_h}{I_{\max}} = \frac{3{\cdot}5 \times 200}{400} \cdot 10^6 = 1{\cdot}75 \times 10^6 \text{ cycles/Oe. sec.}$$

In our opinion the approximate agreement between theory and experiment warrants the conclusion that the rapid decrease of μ_0 in ferrites at high frequencies is probably due to gyromagnetic resonance around directions prescribed by the internal fields.

J. L. Snoek

Natuurkundig Laboratorium
der N.V. Philips' Gloeilampenfabrieken,
Eindhoven.
March 5.

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[1] Landau, L., and Lifshitz, E., *Phys. Z. Sovj. Union*, 8, 153 (1935).

Evaporation of Meteors

THE publication of radar photographs in *The Times* of October 11, 1946, and also in *Nature* on December 28, has brought the question of ionic clouds again to the fore. There is no evidence that the photographs are of visible meteors. They are probably of clouds of electrons at or near the E-layer, usually known as 'scatter clouds'. Visible meteors move. These do not, as was pointed out in the note in *The Times*. (By visible meteors, I mean large meteors which would be visible to the naked eye if there were no ordinary cloud obstruction.) The second photograph in *Nature* of December 28 is, I think, a secondary effect of a meteor shower. We have, in fact, a photographic record taken on November 15, 1937, showing occasions on which visible meteors have produced no scatter cloud for longish wave-lengths between 32·35 and 16·13 metres. The picture in *The Times* may be of scatter clouds produced by invisible meteors evaporating; but it should be noted that meteors are by no means the only cause of scatter clouds, which may equally well be produced before Dellinger 'fades'. We have considerable evidence of this.

The second *Times* photograph may be considered as evidence of an invisible meteor shower. But with regard to the increase in this photograph, taken at 3.40–3.50 a.m., in comparison with the first photograph, taken at 9.15–9.25 p.m. on the previous day, it has been shown that there is always a peak of about three to six to one at about this time, whether there is a meteor shower in progress or not.

A theory which will account for all the effects is as follows: it is supposed that scatter clouds can be produced by small meteors evaporating. (If they are small enough, they do evaporate at great heights. The larger they are, the lower the height at which they will evaporate.) The amount of energy supplied is proportional to the area swept out by the meteor. The amount of energy required to evaporate it completely is proportional to its volume. Thus there must be a size at and below which the energy supplied is greater than that required, and small enough meteors will evaporate, producing scatter clouds. It is probably these scatter clouds which *The Times* photograph shows, and not visible meteors.

The fundamental idea which makes a complete understanding possible is published in "Studies in Radio Transmission"[1]. It is this: that there is a very close analogy between the scattering of radio waves from scatter clouds and the scattering of alpha particles from heavy molecules. This leads to the Rutherford fourth-power law. The ratio of the scattered to the primary signal E/E_0 for a constant number of particles is proportional to $(\lambda/a)^4$, where a is the radius of the cloud. It is thus only the small clouds which scatter effectively, and not the big clouds. The big clouds are visible meteor trails. The small clouds are the evaporating invisible meteors, and it is these that we see in the radar photograph. The fourth-power law for λ has been checked experimentally and theoretically, and I think there is no doubt about this. According to this explanation, the whole of the results are intelligible.

T. L. ECKERSLEY

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[1] *J. Inst. Elect. Eng.*, **71**, 405 (1932).

Chromatic Correction of Wide-Aperture Catadioptric Systems

IN the Schmidt camera system, where the spherical aberration of a mirror for a selected wave-length of light may be completely corrected by a suitably figured plate at the centre of curvature, there remains a chromatic variation of spherical aberration which sets a limit to the performance on the axis and for small angles of field, and which, for large relative apertures, becomes undesirably large. The effect is commonly reduced by introducing first-order axial chromatic aberration by using a corrector plate in the form of a figured lens of finite power instead of a figured plane parallel plate, the form in which the axial and marginal thicknesses are equal being not far removed from the optimum. Fig. 1 shows the departures (measured in d wave-lengths per 25 mm. of focal length) of the C and g emergent wave-fronts from the spherical d wave-front for a Schmidt system of relative aperture $f/0\cdot7$, using for the corrector plate a borosilicate crown glass, $n_d = 1\cdot516$, $V = 64\cdot1$, the maximum aberration for g being 1·5 wave-lengths when the marginal and intermediate zonal errors are equalized. The chromatic difference of spherical aberration is, of course, of the sign corresponding to an increase of glass-path with increasing aperture.

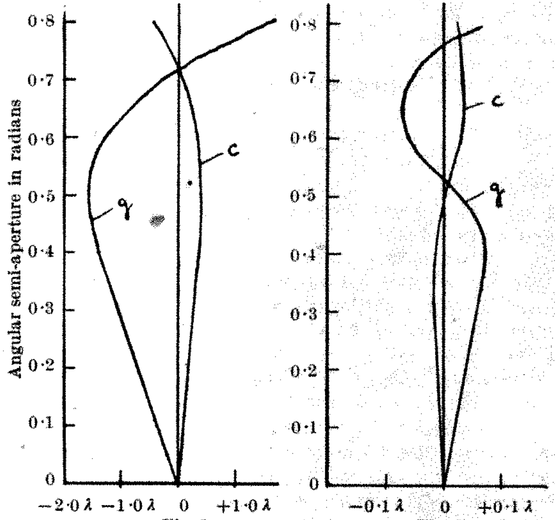

Fig. 1 Fig. 2

ABERRATION OF THE EMERGENT WAVE-FRONTS FOR C AND g PER INCH OF FOCAL LENGTH WITH RESPECT TO THE SPHERICAL WAVE-FRONT FOR $f/0\cdot7$ SYSTEMS

In the systems in which one or more spherical-surfaced meniscus lenses are used to correct the mirror aberration[1,2], the chromatic difference of spherical aberration is of similar magnitude to that of Schmidt systems, but of opposite sign, since the paraxially achromatic meniscus has an effective glass-thickness decreasing with aperture; this is normally minimized by introducing first-order axial colour of opposite sign to that used in Schmidt systems, resulting in curves practically identical with those in Fig. 1 but in the reverse sense. This fact, which does not appear to have been noted hitherto, obviously offers the possibility of a very considerable reduction of the residual chromatic aberrations by a combination of the two forms of corrector.

Preliminary calculation of an $f/0\cdot7$ system consisting of two menisci concave to, and on each side of, the mirror centre with a figured aspheric corrector plate between them shows that the colour errors may readily be reduced to one twentieth of that of either the Schmidt or two-meniscus systems; the corresponding curves for C and g are shown in Fig. 2, on a scale ten times that of Fig. 1. Such a lens has much thinner menisci than are necessary in the two-meniscus systems previously described[2]. The monochromatic oblique aberrations are, of course, not so good, though better than in the corresponding Schmidt, since the figuring on the plate is only about two thirds as great. For small angles of field this type of system would appear to offer pronounced advantages where very large apertures and considerable focal lengths are required.

Further investigation is in progress and a fuller account may be published later.

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[1] Maksutov, D. D., *J. Opt. Soc. Amer.*, **34**, 270 (1944); *Nature*, **155**, 798 (1945).

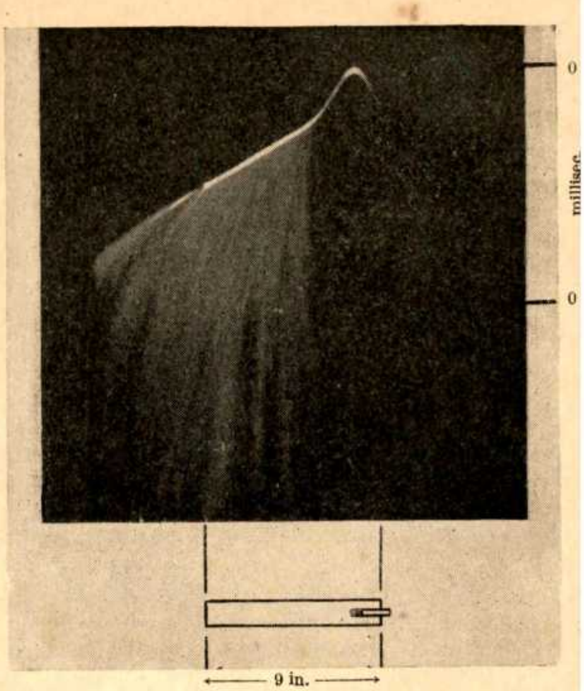
[2] Wynne, C. G., *Nature*, **155**, 583 (1946).

Speed Around the Initiating Point of the Detonation Wave in High Explosives

IN a recent communication[1], Weibull describes an interesting experimental technique and discusses the establishment of detonation in charges of compressed T.N.T., initiated by a No. 8 compound detonator; it would seem, however, that a general conclusion is drawn from these experiments, one which is not justified by their scope.

The conclusion, that there is no pre-detonation phase, applies only in special cases, and it does not accord with general experience either with solid explosives or with gaseous mixtures in which detonation is possible. The initiation of detonation in a charge of explosive is controlled by several factors, notably the sensitivity of the explosive and the strength of the initiating source. The accompanying reproduction is a record, taken by C. A. Naylor with the Buxton rotating-mirror camera, of the inception of detonation in a cylindrical charge, 1¼ in. diameter, of powdered tetryl, of density 1·10, initiated by means of a No. 6 detonator. This initiator was not strong enough to ensure immediate detonation, and the pre-detonation phase lasted until the explosion had traversed nearly one third of the cartridge; detonation was then set up, the rate being 4,680 metres per second. With progressively stronger initiators the extent of the pre-detonation phase was correspondingly reduced and the rate of propagation during this phase was increased, until, finally, there was no perceptible delay in the inception of detonation.

Thus, in border-line cases, it might be difficult to detect the establishment of detonation, and it is not felt that the photographic technique described by Weibull could decide this point with certainty, especially with high-rate explosives, for the method is not capable of the precision necessary for differentiating between speeds differing by less than 200–300 metres per second; the time-scale of photographic records of this nature cannot be read to a greater accuracy than 0·01 mm., which with a film speed of only 100 metres per second (0·1 mm. per microsec.) gives rise to an appreciable error when the quantity being measured is the *difference* between



the times taken by two wave fronts advancing at similar rates (about 6,800 metres per second) to travel distances which differ only by 0–3·2 cm.

Most important, however, is the fact that it is not possible to decide whether or not an observed 'explosion' developed under special experimental conditions is being propagated as a true detonation wave at the appropriate rate until this rate has been actually measured for the particular explosive as made up and used. For the rate of detonation depends on the nature and physical state of the explosive and also upon the conditions under which it is fired; for example, with a crystalline explosive like T.N.T., the rate depends on the crystal size and on the bulk density; within certain limits it depends also on the degree of confinement and on the size of the charge. It is possible also that there is a real though small difference in the rates of detonation, (1) during the initial stage when the wave is spreading spherically from the source to the bounding surface of the charge, and (2) when the wave is being propagated as a more or less plane wave through the remainder of the charge.

Weibull concludes that he is dealing with detonation only in so much as the velocity deduced from his experiments is 7,470 metres per second, a value some 700 metres per second higher than that given by Stettbacher[2] as the rate for T.N.T. (at a density of 1·62) and which, Weibull suggests, is at fault, though he fails to specify the density of his own charges. In our wide and varied experiments with T.N.T., the maximum rate ever measured over a long single cartridge (density 1·62) is nearly 6,950 metres per second; and it is suggested that the higher speed inferred by Weibull from his indirect records is due to the fact that he applied a technique to the measurement of phenomena far beyond its limits of accuracy.

There remains an old, and not yet explored, suggestion that the velocity of detonation of a crystalline explosive might be found to differ along different axes of a crystal. In a pellet of compressed

T.N.T., where the small crystals are irregularly disposed, this factor would not arise. But in a cast charge in which the crystal growth was carefully controlled, there might be detectable differences depending upon the orientation of the crystals with respect to the direction of propagation of the detonation wave.

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Explosives Section,
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April 17.

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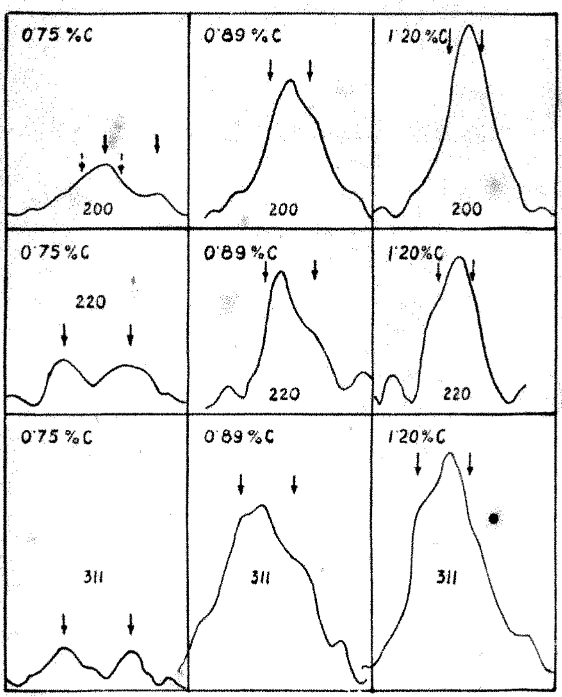
[1] Weibull, *Nature*, **159**, 402 (1947).

[2] Stettbacher, "Die Schiess- und Sprengstoffe" (1933).

Structure of Retained Austenite in Plain Carbon Steels

THERE are many indications that retained austenite in quenched plain carbon steels should be regarded as a face-centred tetragonally distorted structure and not face-centred cubic as heretofore.

The tetragonality is shown either by pronounced broadening or distinct separation of the lines, depending on the carbon content in solution, that is, the amount of austenite. This is shown in the accompanying intensity curves of lines 200, 220 and 311 (photometer curves with uncorrected intensity and background equal to zero) of retained austenite present in quenched samples of steels with 0·75, 0·89 and 1·20 per cent of carbon. The shapes of these curves show that the tetragonality decreases with the increase of the amount of retained austenite.



By quenching iron–carbon alloys from the gamma modification the amount of the austenitic pseudophases, which have been called γG, γS, and γE[1], can be revealed. Since the grain in the above-mentioned quenched steels is made up of martensite and austenite, and since γS produces martensite and γE austenite, there is a strong 'linkage' between the two phases due to the sharing of iron atoms in the interfaces by both the austenite and the martensite.

The presence of martensite and austenite in phases differing in structure and parameter and linked closely together causes a tetragonal distortion of each with respect to the other. Martensite is tetragonally distorted in such a way that $c/a > 1$, whereas in distorted austenite $c/a < 1$. In the above-mentioned steels (0·75, 0·89 and 1·20 per cent of carbon), the tetragonality of retained austenite could as a first approximation be estimated as 0·9945, 0·9960 and 0·9975 respectively.

Further investigation is in progress, and it is hoped that more detailed discussion of some of the questions which emerge from the above finding will be published in due course.

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[1] Wrazej, W. J., *Nature*, **158**, 308 (1946).

Flow of Smoke through a Hole in Resonant Cavity

PROF. G. D. WEST[1] has used a smoke-filled cavity as a resonator and noted the stream of smoke issuing from a hole near the base; radiation pressure was suggested as a possible cause. In an alternative explanation[2], Prof. E. N. da C. Andrade suggests that air is simply expelled during one half-cycle in a definite smoke-laden stream, and is drawn in during the next half-cycle, air being sucked in from all sides.

The matter can readily be settled by reversing Prof. West's experiment. According to Prof. Andrade's explanation, smoke outside the resonator should appear to stream in just as readily as it streamed out in the original experiment. This has been done, and the effect has been found to be reversible.

A variation of Prof. West's experiment was made as follows: A length of 2 in. diameter transparent 'Plexiglass' tubing was made to resonate as a 'closed pipe' at its first overtone (the length of the pipe thus being three quarters of the fundamental wavelength). The system was driven by a moving-coil speaker mounted at the open end of the pipe and connected to an electronic oscillator operating at 500 cycles. Pinholes were drilled in the pipe at the two pressure antinodes and at the pressure node between them. When the tube was filled with smoke and the driving source switched on, it was observed that smoke rushed from the pinholes at the antinodes but did not issue from the node if this pinhole was carefully located.

The reverse experiment was then carried out. The tube was cleared of smoke and was made a resonator as before. A short piece of similar tubing was filled with smoke and fitted tightly to the first tube over each of the pinholes in turn, using 'Plasticine' to seal the connexion. Smoke was observed to rush into the resonating tube at both pressure antinodes.

F. W. SIMPSON

National Research Council,
Ottawa.
March 13.

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[1] *Nature*, **158**, 755 (1946).

[2] *Nature*, **159**, 132 (1947).

Antagonistic Effect by Certain Growth-Stimulants of the Tuberculostatic Activity of 5-Amino-2-butoxypyridine

THE powerful inhibitory action of 5-amino-2-butoxypyridine on the growth of *Mycobacteria*, which is highly specific for members of that genus, has recently been reported[1,2]. Strains of *M. tuberculosis* (including the human-type *H37Rv*) and *M. phlei* were inhibited at dilutions of this compound so high as 0·03–0·001 mgm. per cent in Dorset's synthetic or in Proskauer–Beck medium, inoculation being either on the surface by a small piece of pellicle or by a suspension of about 20,000 organisms per ml.

As we had immediate access to the compound, in the form of the dihydrochloride, we have sought independent confirmation of these remarkable observations. We have used *H37Rv* (from the American depot at Trudeau Sanatorium, Saranac Lake) and a bovine-type strain *SB* (from Mr. R. E. Glover) as examples of *M. tuberculosis*, as well as a laboratory strain (*P*) of *M. phlei*. Growth was completely or almost completely inhibited at drug concentrations of less than 0·1 mgm. per cent under the following conditions:

(i) *Surface culture* of *H37Rv* in Proskauer–Beck medium, and of *P* in digest broth and in a modification of the synthetic basal medium of Dubos[3] (Difco Casamino acid, 2·5 gm.; asparagine, 0·3 gm.; anhydrous Na_2HPO_4, 2·5 gm.; KH_2PO_4, 1·0 gm.; sodium citrate, 1·5 gm.; $MgSO_4, 7H_2O$, 0·6 gm.; glycerol, 25 ml.; distilled water to 1 l.);

(ii) *Sub-surface culture* of *H37Rv*, *SB* and *P* in the synthetic basal medium, and of *H37Rv* in Proskauer–Beck medium, the inoculum being 0·04 mgm. moist weight of bacilli per 5 ml. medium in a 25 mm. diameter test-tube; *M. tuberculosis* surface cultures were read at 30 days, and sub-surface cultures at 14 days; *M. phlei* surface and sub-surface cultures were read at 4 days. In these findings we are in agreement with the American workers.

Addition of 0·25 per cent serum albumin (bovine plasma fraction V) to the Proskauer–Beck medium and to the broth had no apparent effect on the marked inhibition of growth of surface-cultured *H37Rv* and *P*, respectively. Such addition to the synthetic basal medium carrying a surface transplant of *P* resulted in some delayed surface growth in the higher dilutions of the compound where there had been complete inhibition in the absence of albumin, and, moreover, growth was noted in the depth of the medium even at a drug concentration of 20 mgm. per cent.

The conditions governing the bacteriostatic activity of aminobutoxypyridine in sub-surface culture were, therefore, examined more closely. It was found that, in sub-surface culture, its inhibitory effect against *H37Rv*, *SB* and *P* in the synthetic basal medium was considerably reduced by the addition of albumin, substantial granular growth, or diffuse growth in the case of *P*, being evident at the highest drug concentration tested (10 mgm. per cent). This antagonistic effect is not specific to albumin, since a similar result was obtained if the latter was replaced by the non-ionic synthetic detergent 'Tween 80' (a polyoxyethylene derivative of sorbitan mono-oleate) at 0·05 per cent; this product is known for its marked stimulating and dispersing effect on the growth of *Mycobacteria*[3]. The simultaneous addition of albumin and 'Tween 80' led to total, or almost total, abolition of inhibition of the three strains over the range of drug concentration tested (10–0·1 mgm. per cent), profuse diffuse growth occurring at 10 mgm. per cent. To test the possibility that some constituent of the synthetic basal medium might be a factor, these experiments were repeated with *H37Rv* in the Proskauer–Beck medium; the bacteriostatic effect shown in the medium alone over the range of drug concentrations, 10–0·1 mgm. per cent, was totally abolished by the addition either of albumin, or of 'Tween 80', or of both. Finally, the effect of reducing the inoculum was examined; with 1/100 the usual inoculum of *H37Rv* and 1/1,000 that of *P*, the inhibition previously observed was evident in the synthetic basal medium, but definite growth was again noted in the tubes containing albumin, or albumin and 'Tween 80', and the drug at a concentration of 10 mgm. per cent.

Certain factors or combinations of factors can, therefore, antagonize to a marked degree the inhibitory effect of aminobutoxypyridine on the growth of *Mycobacteria*. This antagonism can be observed in sub-surface culture when carried out in the presence of serum albumin or of certain growth-stimulating lipids. The antagonistic effect of serum albumin was surprising in view of the fact that Feinstone[1] has stated that the tuberculostatic activity of the drug was not antagonized by up to 25 per cent of whole blood or serum. The present findings have an unfavourable bearing on the possibility of this substance proving a useful chemotherapeutic agent. It should be added that both streptomycin and licheniformin show clear inhibitory end-points under the conditions of sub-surface culture in the Dubos albumin–'Tween 80' medium described here.

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P. D'ARCY HART
JAMES WALKER

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Hampstead, London, N.W.3. April 23.

[1] Feinstone, W. H., *Proc. Soc. Exp. Biol., N.Y.*, **63**, 153 (1946).

[2] Feinstone, W. H., Friedman, H. L., Rothlauf, M. V., Kelly, A. M., and Williams, R. D., *J. Pharmacol.*, **89**, 153 (1947).

[3] Dubos, R. J., and Davis, B. D., *J. Exp. Med.*, **83**, 409 (1946).

Sex Reversal in *Patella coerulea* L. and *Diodora gibberula* (Lam.)

CREWE[1] has recently discussed the possible influence of helminth parasites on sex determination in limpets. Following the earlier observations of Orton[2], I have been studying the problem of sexuality in the Mediterranean limpet *Patella coerulea* L., both statistically and histologically. In contrast to the conditions in *Patella vulgata*, no larval Trematodes have been observed in several thousands of *P. coerulea* which I have examined. These parasites must therefore be at most extremely rare in the present populations of *Patella* in the Bay of Naples.

My statistical observations with *P. coerulea*, represented graphically in the appended diagram, show the sex proportions in different size-classes in the months November, January and March. The total numbers examined are given: fuller numerical details will be published elsewhere.

The data available permit the following conclusions to be drawn: (*a*) most individuals of *P. coerulea* undergo sex inversion from the male to the female phase as they grow older; (*b*) a small proportion seem to be determined as females from the beginning of sexual differentiation; (*c*) a small proportion remain as males throughout life; (*d*) sex inversion may occur in any size class; (*e*) the rate of sex inversion does not keep pace with the rate of increase; this fact is made evident by the shift in the point of

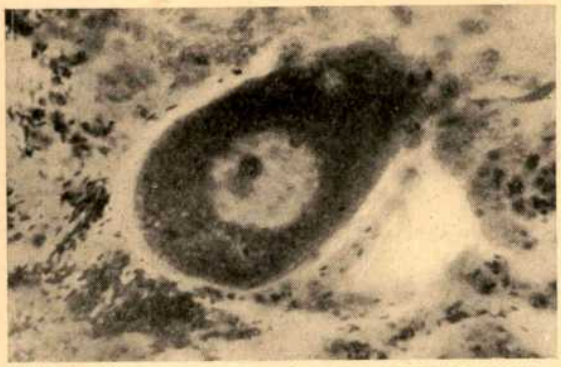

Fig. 1. YOUNG OOCYTE IN A PREDOMINANTLY MALE GONAD

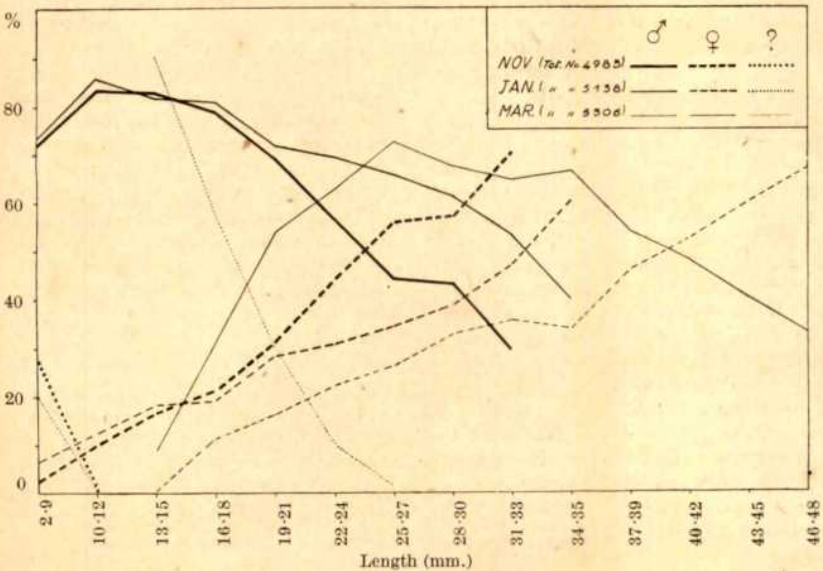

Fig. 2

intersection of the curves for males and females from lower to higher size-classes during these months.

Histological evidence is fully in support of these conclusions. Sex inversion can be observed: young oocytes can be found in gonads which are predominantly male (Fig. 1). A few young individuals show female gonads with no trace of a preceding male phase. Gonads in the state of inversion are found in individuals of various size-classes. Sex inversion generally occurs immediately after the spawning of the male products. This accounts for the different rates of sex inversion and increase in size during the breeding season. Furthermore, histological examinations show that the gonads of *P. coerulea* have no distinct male and female territories. The morphologically hermaphroditic stage is of very short duration.

Analogous conditions have also been found to obtain in another primitive prosobranch, *Diodora gibberula* (Lam.).

Sex inversion in *P. coerulea* at Naples, in the absence of trematode parasites, leads one to suppose that the presence of trematode parasites in *P. vulgata* may only accelerate the normal process of inversion.

G. BA[illegible]CI

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April 17.

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[1] Crewe, W., *Nature*, **159**, 238 (1947).

[2] Orton, J. H., *J. Mar. Biol. Assoc.*, **15**, 852 (1928); *Nature*, **158**, 173 (1946).

Relation of Total Soluble Solids in the Cell Sap of *Sesamum* Species to the Degree of Susceptibility and Resistance to *Antigastra* (Lepidoptera–Pyralidæ) Attack

It has been found that *Sesamum orientale* L., which is grown widely in India as an oil-seed crop, is very susceptible to *Antigastra catalaunalis* Dup. (Pyralidæ) caterpillar attack, and also to phyllody or 'Green flower disease', believed to be caused by a virus. There also occurs in India a wild species of *Sesamum* prostrate in habit which, according to Ramanujam[1,2], is resistant to both *Antigastra* and virus attack. In order to evolve pest- and disease-resistant strains of cultivated *Sesamum*, crosses were attempted between *S. orientale* (I.P.6) and *S. prostratum*, which resulted in the synthesis of a hybrid species *S. indicatum*. This synthetic species was reported to be intermediate in respect of parental characters, but showed, according to the author, greater resistance to the pest and to phyllody than the cultivated species.

Under laboratory conditions, an attempt was made to discover the degree of food preference of *Antigastra* for the three different species of *Sesamum*; it was found that under identical conditions they prefer *S. orientale* and *S. indicatum*. The laboratory observations thus support the field observations.

While it is almost certain that the resistance of certain varieties or species is dependent upon the absence of some chemical groups attractive to insects which infest them, others are resistant because of the existence of substances that might have a repellent action. Yamasaki and Arikado[3] determined the Brix value of varieties of sugar-cane susceptible, and of those resistant, to the attack of white louse *Ceratovacuna (oregma) lanigera* Z., and concluded that there probably exists a minimum critical point in the Brix value for attracting the white louse, which according to them was 4·5 (Ref. Brix). In the absence of any definite external physical characteristic in the plants affecting such resistance or susceptibility, an attempt was made to determine the relationship, if any, of the total soluble solids present in the three different species of *Sesamum* with their susceptibility or resistance to *Antigastra* attack, and the following results were obtained:

Species of plants	Brix value of leaf (Abbe extract refractometer)		Resistant or susceptible
	Range	Mean	
Sesamum orientale (Cultivated species)	1·344–1·346	1·345	Susceptible
Sesamum indicatum (Hybrid species)	1·338–1·340	1·339	Susceptible
Sesamum prostratum (Wild species)	1·351–1·352	1·351	Resistant

The above results indicate to a certain extent that when the Brix readings of the cell-sap is between 1·338 and 1·346, the species concerned are likely to remain susceptible; and when the readings were 1·351 or above, the species were less susceptible or resistant. It is thus likely that the presence of excess soluble solids in the cell-sap of the leaves of the wild species of *Sesamum* renders it less liable to *Antigastra* attack. Further work on these lines is in progress.

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[1] Ramanujam, S., *Curr. Sci.*, **11**, 426 (1942).

[2] Ramanujam, S., *Curr. Sci.*, **13**, 40 (1944).

[3] Yamasaki, M., and Arikado, H., Proc. 6th Int. Soc. Sugar Cane Tech., 475 (1938).

Occurrence of *Botrytis Fabæ* Sardiña in England

THE Chocolate Spot disease of broad and field beans is well known and widespread throughout Great Britain, and causes considerable loss of crop when there is high humidity and much rain at the time of flowering. The cause of the disease, in the eastern counties at least, was shown by A. R. Wilson[1], in 1937, to be the common fungus *Botrytis cinerea* Fr. He proved, however, that similar symptoms could be brought about by other *Botrytis* species, such as *B. Tulipæ* Lind.

We have now shown that in the south-west of England, Chocolate Spot is caused mainly by *Botrytis Fabæ* Sardiña. This fungus was described from Spain by Sardiña[2] in 1929, and has been recorded also from Morocco, Cyprus, Egypt and China. It is readily distinguished from *B. cinerea* by its larger spores and smaller sclerotia. Our identification has been confirmed by Dr. P. H. Gregory.

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National Agricultural Advisory Service,
Bracken Hill,
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May 5.

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[1] Wilson, A. R., *Ann. Appl. Biol.*, **24**, 258 (1937).

[2] Sardiña, J. R., *Mem. Soc. esp. Hist. nat.*, **15**, 291 (1929).

Speciation in Cichlid Fishes of East African Lakes

PROF. C. KOSSWIG has suggested[1] that factors which may contribute to the high evolutionary response of Cichlid fishes to the environments of the Great African Lakes are selective mating and specialized breeding habits, including monogamy at least until one brood becomes independent. A beginning has been made in the study of a group of closely related species in Lake Nyasa, the *Tilapia* of the *T. squamipinnis* group[2,3]. Before 1939 these had been considered as a single species. Slight differences in pharyngeal dentition had been observed in the larger fishes among a score of specimens in the British Museum (Natural History); but these, and slight variations in proportions of head and mouth, had not been thought sufficient for the recognition of more than one species. Field-work during the fishery survey of 1939 revealed that there are in Nyasa probably four closely related species, for some of which it is still convenient to use local names, Chambo, Saka, Lidole and *T. karongæ* (the local name of which I do not know). These seem to be the Nyasa representatives of the *T. galilæa* group of the genus, but all resemble each other much more closely than any species outside the Lake. Females and non-breeding males of all are silver-grey with nearly vertical black bars. In Chambo the male becomes pale blue as the testes ripen; in the other three, ripe males are black. The four species (if they are species) cannot yet be recognized at all stages, but Lidole and Chambo can be distinguished from each other at a total length of 26 cm. and more, and it is to these two that the following remarks apply.

The morphological differences between them are that Lidole has a more slender and more feebly toothed lower pharyngeal bone, usually a larger head and a larger mouth. The essential differences, that is, those that isolate them from each other, are: the breeding male of Lidole is black, that of Chambo is pale blue; the female of each shelters the young in her mouth, but only Chambo brings them into the reed-beds; Chambo ceases to shelter the young after they have reached a total length of 15 mm., Lidole continues to shelter them in her mouth up to a length of 40 mm. In addition there is evidence suggesting that Chambo inhabits a more inshore, Lidole a more offshore zone, although these zones overlap; and that the mating places are separate, that of Lidole being farther from shore than that of Chambo. Both species feed mainly on phytoplankton, and it would need a very extensive study to establish any average difference in the feeding habits. Presumably, however, Chambo has more opportunity to vary the plankton diet with periphytic Algæ or those of the bottom film, and the floating matter of the inshore water would include coarser organic debris than that of offshore water. The slight difference in dentition may be associated with these facts.

If it be assumed that the inshore habit is the more primitive, recent events show how the offshore habit may have been assumed. Since 1939, the level of Nyasa has risen, and in 1945 and 1946, when Miss R. Lowe went to Nyasaland to continue the *Tilapia* studies begun by my colleagues and myself in 1939, the reed-beds, where it was customary to trap Chambo, and near which it was customary to seine them in the breeding season, were drowned, and the native fishing season was a failure. European fishermen, however, fished in open water with special gear and, I understand, caught Lidole, and one of the other species. It may have been such a change in lake-level that first gave rise to a race of *Tilapia* that managed to do without the reed-beds as nurseries for their young, sheltered them in the maternal mouth longer in compensation, and kept to the open water and a purely planktonic diet. A fall in lake-level could provide locally the conditions favourable to the evolution of a more inshore form from a specialized lacustrine form. This may perhaps account for the presence of the other two species, repeated fluctuations resulting in an alternating direction of the evolutionary process, with the fixation of partially converging forms occupying overlapping ecological niches.

In these species, at least, it is only the female that has been found sheltering young in the mouth. The evidence points to a separation of the sexes during the period when the young are being sheltered. In the case of Chambo, males and females were caught in the shore-seines, but the only adults caught in traps among reeds were spent females, some with young. Of Lidole, from the end of January to the beginning of May the inshore methods used caught 120 (recorded) spent females, some with young, and only four males, none in breeding condition. No specimens were recorded with eggs in the mouth, and it is possible that until the fry hatch the parents may remain together near the 'nest'.

The habits of Saka and *T. karongæ* are still undescribed, but Miss Lowe has been studying these fishes in the field for eighteen months, and her results should advance our understanding of this problem.

A pair of species paralleling Lidole and Chambo was described in Lake Victoria by Graham[4,5]. Morphological and colour differences between these are more pronounced. As well as the specific colour, there is evidence of breeding isolation in that in one species the male has the genital papilla elaborated into a brightly coloured tassel at breeding time, in the other it has not; and that breeding females, or spent females with young in the mouth, are trapped in fences across creeks and inlets in the case of one species, but not the other. Graham[5] records that the offshore species "incubates the eggs in her pharynx and no doubt shelters the young", but of the inshore species, although females sheltering young in the mouth were recorded, none was found with eggs in the mouth.

There is no doubt that the detailed study of the specific characters, ethological as well as morphological, of the Cichlidæ of the African lakes offers a unique and fruitful field for the student of evolution.

ETHELWYNN TREWAVAS

British Museum (Natural History),
London, S.W.7.
May 13.

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Copper in Diatoms

THE communication on this subject in *Nature* of May 10, from Mr. N. I. Hendey[1], raises a number of points which require some comment.

The reported values of the concentration of copper in sea-water vary from 0 to 30 mgm./m.^{3}, and Mr. Hendey's figure of 0·007 mgm./l. (7 mgm./m.^{3}) lies within this range. Taking an approximate mean value of the copper content of diatoms given by Mr. Hendey as 100 μgm./gm. and even assuming they contain only 10 per cent dry matter, the concentration factor for copper is of the order of 1,400. The magnitude of this value in relation to the small reported figures for the concentration of copper in sea-water would suggest that copper might play an important part in the economy of diatom outbursts, if this element is a vital constituent of the diatom cell and if planktonic forms have copper contents of this order.

However, the diatoms analysed (samples 3–11) were taken from Group 1, namely, those living in frondose colonies of mucous filaments, and it appears possible that the copper was largely contained in the embedding mucus. It has been shown repeatedly here[2] that mucous films absorb large quantities of copper from sea-water, when exposed to this element either under culture conditions, or even when in proximity to raft-exposed anti-fouling compositions releasing copper.

Further, Mr. Hendey suggests that the diatom slime film which develops upon underwater surfaces may be considered as a potential reservoir of copper, and so may play an important part in preventing the settlement of other fouling organisms. A considerable amount of evidence has now been accumulated which indicates that anti-fouling action is dependent upon the rate of loss of poison from the surface; for effective action this rate should exceed a critical value[3,4]. Mr. Hendey does not present any evidence which suggests that the copper associated with the diatom slimes is capable of release; indeed, the reverse is suggested by the implication of his speculations on the form in which the copper is contained.

Studies of the fouling settlement which occurs on surfaces releasing copper certainly confirm the fact that some diatoms are relatively insensitive to this poison; but no evidence has been obtained, in the course of many thousands of assessments of anti-fouling compositions, that the slimes associated with such diatom settlements can act effectively as anti-fouling surfaces.

If a composition which is capable of maintaining an effective leaching-rate for a period is immersed in the sea, it usually acquires a covering of diatoms (due to their relative insensitivity); this settlement may persist for some time, during which period the diatoms are in contact with a surface at which the concentration of copper is far higher than that of sea-water. These conditions would therefore seem much more favourable for uptake of copper by the diatom slime; yet, in our experience, such a slime immediately gives place to more sensitive fouling organisms once the leaching-rate of the paint drops to a value which allows their settlement.

A cuprous oxide anti-fouling composition containing 10 per cent copper (that is, containing 10^5 μgm./gm.), when applied at a normal weight per unit area, has a very short anti-fouling life (of the order of 100 days) and is not easy to formulate so that the copper is being most economically used. It would therefore be surprising if a diatom slime film containing 164 μgm. copper per gm., the release of which is a matter for speculation, could be more effective than even this type of composition.

It is, of course, possible that the copper contained in the diatom slimes is bound in such a way that it could only be released when another organism came into contact with the slime. Such a condition would represent an advance of the first magnitude in the search for an effective anti-fouling surface; but we suggest that such an action should be sought in a surface considerably more stable and permanent than a diatom slime.

H. BARNES

Marine Biological Station,
Millport.

K. A. PYEFINCH

British Iron and Steel Research Association,
Marine Biological Station,
Millport.
May 23.

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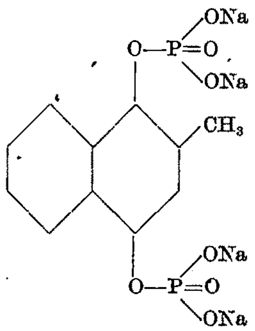
COMBINATION OF SOME EFFECTS OF X-RADIATION AND A SYNTHETIC VITAMIN K SUBSTITUTE

By Prof. J. S. MITCHELL and Mrs. I. SIMON-REUSS
Department of Radiotherapeutics, University of Cambridge

THE present work is part of an investigation to try to improve the results of treatment of neoplastic diseases by the combination of radiotherapy with suitable chemotherapeutic agents. It seems reasonable to examine ancillary chemical agents likely to modify cellular nucleic acid metabolism, since there is now considerable evidence[1] that therapeutic doses of X- and gamma-radiations inhibit the synthesis of thymonucleic acid in proliferating normal and malignant cells.

The compound so far studied in greatest detail is a water-soluble synthetic vitamin K substitute, namely, tetrasodium 2-methyl-1-4 : naphthohydroquinone diphosphate :



It is of interest that Lehmann[2] and Lehmann, Lüscher and Huber[3], using *Tubifex* eggs, showed that 2-methyl naphtho-quinone, the corresponding hydroquinone, and a number of related compounds are inhibitors of mitosis.

In the present investigation the effects of the synthetic vitamin K substitute followed by small doses of X-radiation were observed, using chick fibroblasts in tissue cultures. On the basis of these results, and in view of the recognized low toxicity of synthetic vitamin K substitute[4], preliminary clinical trials, including examination of biopsy specimens, were made in the treatment of selected patients with advanced malignant tumours, which were not likely to respond satisfactorily to conventional radiotherapy. The clinical findings will be reported elsewhere; but it must be emphasized that at the present stage no therapeutic value is claimed.

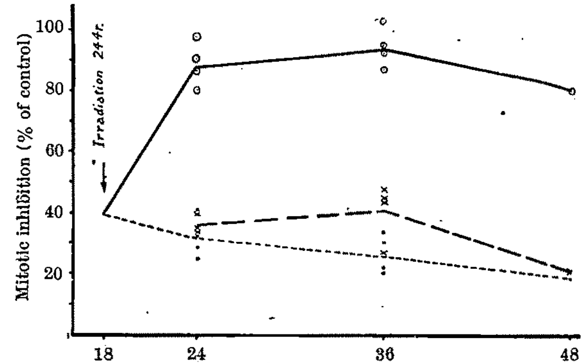


Fig. 1

——, synthetic vitamin K substitute ($3 \times 10^{-6}\,M$) + irradiation 244 r.; – – –, irradiation only (244 r.); . . . ., synthetic vitamin K substitute only ($3 \times 10^{-6}\,M$)

The tissues used for all the culture experiments were taken from the choroid and sclerotic of a 10- to 11-day-old chick embryo. The cultures were grown by the usual hanging-drop technique in a medium of equal parts of fowl plasma and of 15 per cent embryo extract in saline. Two groups of six cultures of the third passage were selected and matched for use as experimental material and controls. The synthetic vitamin K substitute, or other compound to be tested, was added in solution to the embryo extract to give the required final molar concentration. The cultures were fixed in Susa at the times stated and stained with Heidenhain's hæmatoxylin. The total number of mitotic cells in the treated specimens were counted and compared with the number in the untreated controls.

The synthetic vitamin K substitute alone produced mitotic inhibition increasing with concentration. After application for twenty-four hours, at the

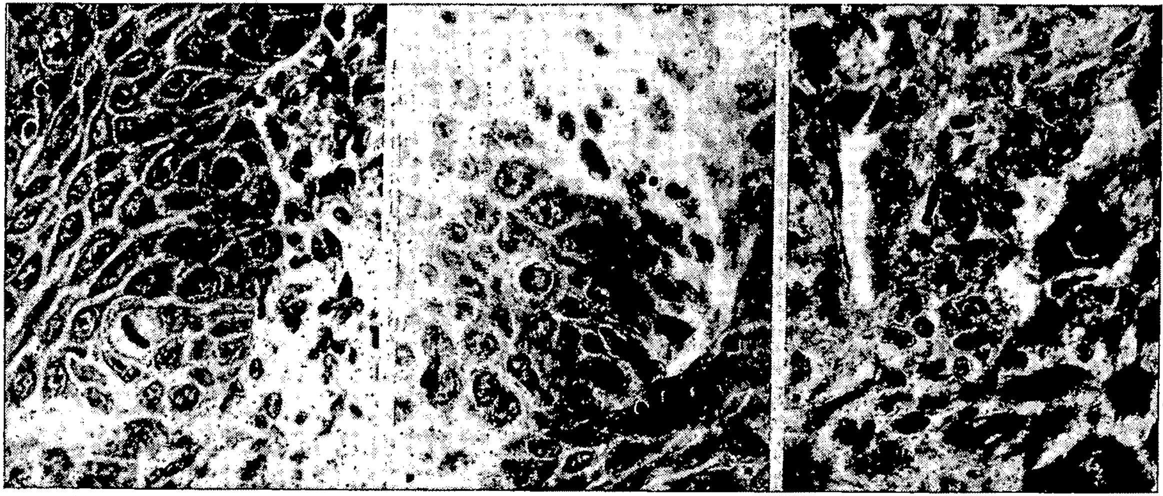

a b c

Fig. 2

following concentrations, the total mitotic counts observed expressed as a percentage of mitosis in the controls were as follows:

(a) $2 \cdot 5 \times 10^{-6}$ *M*, 82·0 ± 4·5 per cent.
(b) 3×10^{-6} *M*, 69·3 ± 2·3 per cent.
(c) 4×10^{-6} *M*, 51·6 ± 1·0 per cent.
(d) 5×10^{-6} *M*, 22·7 ± 4·9 per cent.
(e) 6×10^{-6} *M*, 23·7 ± 4·1 per cent.

For 3×10^{-6} *M* initial concentration, the mitotic count varied with the time of application, having the value after 18 hours, 61·7 ± 4·7 per cent; after 24 hours, 69·3 ± 2·3 per cent; after 36 hours, 75·2 ± 2·9 per cent; and after 48 hours, 82·5 ± 3·4 per cent. The values for 24 and 36 hours are the most reliable.

In each of the experiments showing the effects of X-radiation on the cells treated with the synthetic vitamin K substitute, four sets of cultures were chosen. To two, the compound was added to give a final concentration of 3×10^{-6} *M*; the other two were used as controls for the compound only and for the radiation only. One group treated with synthetic vitamin K substitute and one control group were irradiated after 18 hours with 244 r. of X-radiation of effective wave-length approximately 0·20 A. (H.V.L. 0·5 mm. copper) delivered in 2 minutes. Mitotic counts were made for all four groups at 24, 36 and 48 hours. The results are summarized in Fig. 1, and indicate significant potentiation of the mitotic-inhibiting effects of X-radiation and of the synthetic vitamin K substitute. For example, after 24 hours, X-radiation alone produced 64·9 ± 1·6 per cent of the number of mitoses present in the controls, and synthetic vitamin K substitute alone 69·3 ± 2·3 per cent. The observed effects of the combination produced 14·0 ± 3·8 per cent, while independent action would give 45·0 ± 1·9 per cent. A similar highly significant difference was found at 36 hours; and even at 48 hours, where the experiment is becoming difficult, a significant effect was found.

With regard to the preliminary clinical trials, the qualitative findings so far are not inconsistent with the above measurements. The low toxicity of the synthetic vitamin K substitute has been confirmed. In twenty-five patients with advanced cancer, no attributable toxic effects were observed with doses of 100 mgm. administered intramuscularly daily for times up to six weeks. One man received 500 mgm. intramuscularly daily for 42 days without any demonstrable toxic effect. X-ray therapy was commenced at least three days after the synthetic vitamin K substitute.

The histological changes found in biopsy specimens are exemplified in Fig. 2, which shows typical fields, for a case of advanced squamous cell carcinoma of the floor of the mouth: (a) in the control biopsy specimen; (b) in that taken after administration of 100 mgm. of synthetic vitamin K substitute daily for 16 days; and (c) that taken at 4 days after the end of a course of X-ray therapy in which the minimum tumour dose 3,500 r. was delivered in overall time 8 days, by which time the synthetic vitamin K substitute had been given for 44 days. In the control specimen (a) 5,000 cells were counted, and the frequency of mitosis was 3·98 ± 0·28 per cent. In (b), after synthetic vitamin K substitute alone, the frequency of mitosis was found by counting 10,000 cells to be 1·12 ± 0·11 per cent, indicating a highly significant reduction. Further, the ratio of prophases to metaphases was significantly reduced. After the irradiation, counts were impossible because all the tumour cells were grossly degenerate. At the doses used, the synthetic vitamin K substitute alone produced many mitotic abnormalities, including clumping and stickiness of chromosomes and anaphase bridges.

Summarizing: a synthetic vitamin K substitute, tetrasodium 2 - methyl - 1 : 4 naphthohydroquinone diphosphate, produces mitotic inhibition in chick fibroblast cultures and in some human carcinomata. In the tissue cultures, significant potentiation of the effects of X-radiation and of the synthetic vitamin K substitute in inhibiting mitosis is found under suitable conditions. Preliminary clinical trials confirm the low toxicity of the synthetic vitamin K substitute. At the present stage of investigation, no therapeutic value is claimed.

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PLASTIC OPTICAL SYSTEMS FOR TELEVISION

IN the type of television receiver most commonly used at the present time, the picture is produced on the fluorescent screen of the cathode ray tube, which is viewed directly or through a suitably placed plane mirror. The 9- or 12-in. cathode ray tubes normally used give pictures of about 8 in. by 6 in. in dimensions, while a somewhat larger picture is obtained with a 15-in. tube. This, however, probably represents the practical limit of picture size in this type of domestic receiver, since larger cathode ray tubes are unwieldy and expensive items. At the same time, it is desirable that the television receiver of the future should produce a picture of about twice the above size in linear dimensions, and preferably on a flat screen. With this object in view, developments had begun several years ago of a reproducing system using a small cathode ray tube with a fluorescent screen only two or three inches in diameter, on which a bright clear image is produced, the light from this image being then projected through a suitable optical system to give an enlarged picture on a flat screen. While considerable progress has been made in cathode ray tube design, the picture brightness obtainable on the tube is insufficient to give satisfactory results when using an optical system of the conventional type. For this reason the Schmidt optical system, which was originally designed for use in astronomical telescopes, has been applied to the projection of television pictures. The great advantage of this system is that it has a large light-gathering property, and so enables the utmost use to be made of the picture-brightness on the cathode ray tube.

As mounted for use in a television receiver, a deep concave mirror of large aperture is placed opposite the end of the cathode ray tube and projects the light forward past the tube towards the viewing screen. In order to correct for the spherical aberration introduced by a mirror of such large aperture, a corrector plate is introduced into the projection system. This plate has a non-spherical surface of complex shape and, in the Schmidt system, is mounted at the centre of curvature of the mirror. To produce such an optical system in glass is, however, a slow and expensive matter, since the aspherical surfaces of the corrector plate require long and patient hand-work by a highly skilled craftsman. Although many attempts have been made to produce such plates by means of machines designed to work the surfaces automatically, this has so far not been considered to be an economic proposition for the mass-production of domestic television receivers. These limitations have now been largely removed by recent developments in the formation and use of transparent plastic materials, and particularly by the introduction of a surface-finishing process by means of which plastic components of high optical quality can be produced on a large manufacturing scale.

A description of these developments with demonstrations of their application to television reception was given in a lecture on May 29 before the Television Society by Dr. D. Starkie, of the Plastics Division of Imperial Chemical Industries, Ltd. Two plastic materials are available in bulk supply in Great Britain. They are poly-methyl-methacrylate and poly-styrene, and are supplied in optically pure forms as 'Transpex 1' and 'Transpex 2' respectively, with transmission values for visible light corresponding approximately to those of crown and flint glass. These materials are sensibly unaffected by continuous exposure to sunlight, and, although they have a softening temperature of about 120° C., by taking great care to avoid any strain in the material during fabrication, finished components show no measurable change in form when used under the most severe operating conditions. The production of the components takes place in two stages. First, a 'preform' is cast as accurately as possible by some known method. Then a thin skin of the same material is built up on the surface of this preform inside an optically worked glass mould, until the surface of the component makes optical contact at all points with the mould. A transparent mould material is necessary since part of the reproduction process is polymerization by light; but, in addition, glass is the hardest material available in bulk supply and all risk of scratching during use must be avoided. The aspheric moulds are first machined as accurately as possible and then finished by a skilled optical worker by hand. The preparation of such moulds is still a long and expensive matter; and it is only justified by the fact that, once a mould is made, a considerable number of accurate plastic reproductions can be made from it. The time required to make an optical component by the surface-finishing process is quite long, although the actual handling time by the operators is short. It has been decided, therefore, that in order to keep production costs low enough to allow the optical systems to be used in domestic television receivers, a large number of moulds should be used and these should travel through the various stages of the process on a mechanical conveyor. A factory to be operated along these lines is being prepared, and it is hoped to start manufacture at the end of this year.

Dr. Starkie demonstrated two prototype Schmidt television projection systems for home receivers, using cathode ray tubes of $2\frac{1}{2}$ or $3\frac{1}{2}$ in. diameter, respectively. The picture size given by both systems is 16 in. × 13 in., the chromatic aberration is small, and the resolution is claimed to be far better than is required for the present B.B.C. television transmissions using 405-line scanning. Although the smaller of the two systems requires a 'throw distance' of 40 in. between the cathode ray tube and the viewing screen, it was shown how this could conveniently be incorporated in a receiver console of normal dimensions. A third Schmidt system suitable for television projection in small cinemas was also demonstrated: this contained a mirror of 18 in. diameter and gave a picture with a length of diagonal of $12\frac{1}{2}$ ft.

Although the lecture was primarily devoted to the use of plastic optical components in television reception, it was pointed out that since the new surface-finishing process allows complicated aspherical optical components to be made at a reasonable cost, it is likely to have an important effect in the general field of applied optics.

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

OPENING OF SKETTY HALL LABORATORIES

SKETTY HALL, Swansea, was opened on July 3 as the South Wales Laboratories of the British Iron and Steel Research Association. Mr. G. H. Latham, president of the British Iron and Steel Research Association, received a gold key from the Mayor of Swansea, and guests proceeded to an inspection of the Laboratories.

At present the bulk of the Association's work is of necessity carried out through the facilities of its members and at the universities and other appropriate institutions. Nevertheless, considerable progress has been made in establishing a number of laboratories specially adapted for co-operative research. For example, at the University of Sheffield a team is studying problems connected with rolling practice, and plans are well advanced for the establishment of a metal flow station in Sheffield for practical investigations into all forms of metal working and plastic deformation problems; in London, a physics laboratory is shortly to be opened; there is a corrosion-testing laboratory at Birmingham, and marine biological work is carried out at Millport, Scotland.

At Sketty Hall, a mansion with an interesting local history extending over a century and a half, made available to the Association by the Swansea Corporation, comprehensive facilities have been provided.

The chemistry section has a spacious laboratory, and the metallurgical section has two laboratories, all on the ground-floor. The metallurgical rooms are respectively equipped with various heat-treatment furnaces and physical testing apparatus. On the same floor is the small workshop with the instrument mechanic's room adjacent, and the galvanizing and tinning shop, which will be sited in what seems to have formerly been a brew house. This shop is already furnished with ventilation for drawing off the brewery fumes, though the arrangements may have to be improved to dispose of the rather less appetizing by-products of the shop's new functions.

The first floor provides two laboratories for the physics section, and two for the electro-chemical section, in which there is equipment for plating. The physics section, being engaged on investigating the geometrical and physical characteristics of metal surfaces, is equipped with a sensitive profilometer of the latest pattern, and will have electron diffraction equipment later in the year. The profilometer is a Talysurf machine, on which a stylus traverses the specimen and records the roughness of the surface on a graph, with an adjustable magnification of 400–100,000 times. It also provides a rapid 'average' reading for the surface of the specimen.

It was found necessary to instal this equipment on a thoroughly stable base, and one of the physics laboratories has had to be provided with a ferro-concrete floor, on which the Talysurf and the electron diffraction apparatus are to be housed.

The second floor has comprehensive metallographic facilities, with separate preparation laboratory and photographic room.

There are many problems which can be attempted within the scope of these facilities. Besides studies of metal surfaces, there are studies of the thickness and distribution of coatings of various sorts, and of the porosity of coatings. The Swansea team has already done considerable work on these subjects, which promises to be of ultimate benefit both to users and makers of the products concerned. Other problems which it will be the function of Sketty Hall to investigate include such questions as the influence of the composition of the steel and its method of manufacture on surface coatings; the physical and chemical characteristics of metal surfaces; the adhesion of coatings; electroplating; de-wetting and many others.

Other work carried out at Sketty Hall involves field tests on melting furnaces and works in the South Wales area, concerned with such matters as fuel distribution and gas flow in gas producers (in conjunction with the British Coal Utilization Research Association); the effect of deterioration of ingot mould surfaces on the surface of the ingot and subsequent products; the determination of the moisture content of hot raw producer gas, and the assessment of the value of instrumentation of open-hearth furnaces. For these purposes a quick immersion thermocouple is being used, and apparatus has been developed for rapid determination of the moisture in producer gases. These, together with other equipment, are being mounted in a mobile laboratory.

The organisation of the Swansea laboratories is the task of the Coatings Committee of the Mechanical Working Division of the Association, one of the six divisions under which the Association's work is organised. This Committee was formed about fourteen months ago, and the first meeting was held on May 15, 1946, under the chairmanship of Capt. H. Leighton-Davies, who remains the chairman to-day. The terms of reference of this Committee, for which the greater portion of the work of Sketty Hall is to be carried out, are: "To consider and investigate all matters concerning metallic and other inorganic coatings on steel and all processes for surface preparation associated therewith". This is, of course, a very wide field, involving close collaboration between research workers in allied fields (such as the co-operation that exists between the British Non-Ferrous Metals Research Association and the British Iron and Steel Research Association) and between research workers and users.

The formation of the Coatings Committee was not by any means the origin of co-operative research in South Wales, which was started in 1932 by the South Wales Siemens Steel Association and the Welsh Sheet and Plate Manufacturers' Associations. A team of investigators then worked at University College, Swansea, under Mr. D. Luther Phillips.

Early in 1946 arrangements were made for the British Iron and Steel Research Association to take over the work of the two research Committees, and it is the new function of Sketty Hall to house the continuation and expansion of their investigations. Mr. Luther Phillips is now in sole charge of the laboratories, and the closeness of Sketty Hall to University College, Swansea, ensures continuity.

A lunch at Swansea Civic Centre followed the opening ceremony. Besides Mr. G. H. Latham and the Mayor of Swansea, Mr. Percy Morris, M.P., Sir Lewis Jones (vice-president of University College, Swansea), Capt. H. Leighton-Davies and Sir Charles Goodeve (director of the Association) spoke.

Mr. Latham emphasized the part co-operative research has to play in ensuring that we have the steel output as necessary to Great Britain's economic recovery as the output of coal. Throughout all the speeches there was much emphasis on the healthy degree of co-operation which exists between the Research Association, the University College, the municipality and local industry. In inviting industrialists to make the freest possible use of Sketty Hall's facilities, Sir Charles Goodeve stressed the fact that science alone is not a panacea for our ills, but must be allied to strong and continuous effort. Tribute was paid to the very considerable amount of work that had gone into the conversion of Sketty Hall. Its rapid progress must be laid to the credit of Mr. Luther Phillips and his staff, and to the efforts of the contractors.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, July 21

Anglo-Austrian Society (at Gas Industries House, 1 Grosvenor Place, London, S.W.1), at 8 p.m.—Prof. H. Mark (Institute of Polymer Research, Brooklyn): "Austrian Science, Past and Future".

Saturday, July 26

Amateur Entomologists' Society (at Buckingham Gate Central School, Wilfred Street, London, S.W.1), at 2 p.m.—Annual Exhibition.*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Physics (honours graduate, to teach physics to B.Sc. standard) at the Municipal Technical College and School of Art—The Director of Education, Education Office, Library Street, Blackburn (July 26).

Junior Technician for physiological research—The Secretary, The University, Aberdeen (July 26).

Lecturer in Zoology and Chemistry—The Registrar, Merchant Venturers' Technical College, Bristol (July 26).

Lecturer in Mechanical Engineering—The Principal, Dudley and Staffordshire Technical College, Dudley (July 26).

Lecturer in Applied Mechanics at the Royal Naval College, Greenwich—The Director, Education Department, Admiralty, London, S.W.1 (July 26).

Chief Lecturer in Mechanical Engineering—The Registrar, Leicester College of Technology and Commerce, Leicester (July 26).

Lecturer in Geography at the Liverpool College of Commerce—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (July 26).

Lecturer in Chemistry and Mathematics at the Oxford School of Technology—The Chief Education Officer, City Education Office, 77 George Street, Oxford (July 26).

Works Chemist—The Secretary, Rochester, Chatham and Gillingham Gas Company, 95 High Street, Rochester (July 29).

EXPERIMENTAL OFFICER (male) for work in dairy husbandry and farm management—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (July 31).

PRINCIPAL RESEARCH OFFICER, RESEARCH OFFICERS (8), SENIOR TECHNICAL OFFICERS (2), and a TECHNICAL OFFICER, for work concerned with a study of jet propulsion and subsonic, transonic and supersonic flight for military and civil use, at the Long-range Weapons Establishment at Salisbury, near Adelaide—The Deputy High Commissioner, Australia House, Strand, London, W.C.2 (July 31).

LECTURER and an ASSISTANT IN MATHEMATICS—The Secretary, The University, Aberdeen (August 5).

READER IN SURVEYING at King's College, Newcastle-upon-Tyne—The Registrar, The University, 46 North Bailey, Durham (August 8).

PERMANENT LECTURER to take charge of teaching of SCIENCE in senior school courses, a TEACHER OF SCIENCE at the secondary technical school (Merton Road branch), and LECTURERS (2) IN MATHEMATICS in senior full-time and part-time courses—The Principal, Brixton School of Building, Ferndale Road, London, S.W.4 (August 9).

RESEARCH OFFICER, Heat Section, Division of Physics, Sydney—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1170 (August 11).

LECTURER IN PSYCHOLOGY—The Registrar, The University, Manchester 13 (August 11).

UNIVERSITY LECTURER IN THEORETICAL CHEMISTRY, and a UNIVERSITY DEMONSTRATOR IN ORGANIC CHEMISTRY—Dr. F. B. Kipping, Secretary of the Appointments Committee, Faculty of Physics and Chemistry, Chemical Laboratory, Pembroke Street, Cambridge (August 15).

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LECTURER (Grade IIa), and ASSISTANT LECTURERS (2, Grade III), IN THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, University College London, Gower Street, London, W.C.1 (August 15).

SENIOR LECTURER IN GEOLOGY—The Registrar, University College, Singleton Park, Swansea (August 16).

CHAIR OF COLOUR CHEMISTRY AND DYEING—The Registrar, The University, Leeds 2 (August 18).

BIOLOGICAL RESEARCH ASSISTANT—The Superintendent and Secretary, Jessop Hospital for Women, Sheffield 3 (August 23).

READERSHIP IN PATHOLOGY at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (August 28).

ASSISTANT KEEPERSHIPS IN (*a*) GEOLOGY, (*b*) BOTANY, (*c*) ART—The Director, Museum and Art Gallery, New Walk, Leicester (August 30).

PROFESSOR OF ELECTRICAL ENGINEERING (general), a PROFESSOR OF ELECTRICAL ENGINEERING (electrical power generation, transmission, and utilization), a PROFESSOR OF MECHANICAL ENGINEERING and a PROFESSOR OF CIVIL AND HYDRAULIC ENGINEERING, in the Indian Institute of Science, Bangalore—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (August 31).

JUNIOR POSTS IN THE DEPARTMENT OF STATISTICS or one of the Biological Departments, for teaching and research in the use of statistical and other mathematical procedures in the Biological Sciences—The Secretary, University College London, Gower Street, London, W.C.1 (August 31).

PROFESSOR OF CIVIL ENGINEERING CONSTRUCTIONS AND FOUNDATIONS, a PROFESSOR OF STEEL BRIDGES AND METALLIC STRUCTURES, a PROFESSOR OF ARCHITECTURAL CONSTRUCTION, a PROFESSOR OF STRENGTH OF MATERIAL, a PROFESSOR OF DESIGN OF ELECTRICAL MACHINERY, and a PROFESSOR OF EXECUTION DESIGN, in the Faculty of Engineering, Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (August 31).

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (September 1).

LECTURESHIP IN PALESTINIAN ARCHÆOLOGY—The Director, Institute of Archæology, University of London, Regent's Park, London, N.W.1 (September 1).

CHAIR OF PHYSIOLOGY at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 2).

PROFESSOR OF SOCIAL AND PREVENTIVE MEDICINE, and a LECTURER IN PSYCHOLOGY—The Secretary, Queen's University, Belfast (September 6).

RECTOR OF THE CANTERBURY UNIVERSITY COLLEGE, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 15).

LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY, and a LECTURER IN APPLIED CHEMISTRY—The Secretary, The University, Edinburgh (September 15).

PRINCIPAL, SOUTH AFRICAN NATIVE COLLEGE, Fort Hare, C.P., South Africa—The Principal of the College, or The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (South Africa, September 30).

SENIOR ASSISTANT—The Secretary, Appointments Committee, The Observatory, Armagh, Northern Ireland (October 1).

CHEMISTS (2), a CHEMICAL ENGINEER, BOTANISTS (2), a PLANT PATHOLOGIST, an ADVISORY OFFICER (pathologist), and an ADVISORY OFFICER (Soils Chemist), in the Rubber Research Institute of Malaya—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S.W.7.

PLANT PHYSIOLOGIST IN THE BOTANY DEPARTMENT—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8.

LECTURER IN ELECTRICAL ENGINEERING—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

ASSISTANT LECTURER AND DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMICAL PATHOLOGY—The Chemical Pathologist, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1.

LECTURER to take CIVIL AND MECHANICAL ENGINEERING SUBJECTS, with special reference to the Theory and Design of Structures, at the Cardiff Technical College—The Director of Education, City Hall, Cardiff.

LECTURER IN CHEMISTRY (with particular reference to physical chemistry)—The Principal, Medway Technical College, Gillingham, Kent.

LABORATORY ASSISTANT IN THE DEPARTMENT OF BIOCHEMISTRY—The Establishment Officer, University College London, Gower Street, London, W.C.1.

LABORATORY TECHNICIAN IN THE DEPARTMENT OF ZOOLOGY—The Secretary, University Science Laboratories, Durham.

LECTURER IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

DEMONSTRATORS (2) IN PHARMACY—The Registrar, University College, Nottingham.

ASSISTANT LECTURER IN LOGIC AND SCIENTIFIC METHOD—The Secretary, London School of Economics and Political Science, Houghton Street, London, W.C.2.

EDUCATIONAL PSYCHOLOGIST—The Chief Education Officer, Shire Hall, Cambridge.

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Empire Cotton Growing Corporation. A Review of the Work of the Experiment Stations, Seasons 1942–43 to 1944–45. Pp. iv + 22. (London: Empire Cotton Growing Corporation, 1946.) 2*s*. [291

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THE SOCIAL SCIENCES AS A FACTOR IN INTERNATIONAL COLLABORATION

IT is a feature of the reviews of the year's work of the Rockefeller Foundation which its president, Mr. Raymond B. Fosdick, is accustomed to give, that they provide not merely a picture of the activities of the Foundation but also of the fundamental needs and problems in the intellectual as well as the physical life of mankind that the Foundation is trying to serve or to solve. In this way these reviews have come to possess a value for assessing the importance or significance of trends in the scientific world or in the activities of other organisations that is almost unique. The review for 1946 admirably illustrates this characteristic, and will be read with interest and profit by those interested in the new World Health Organisation established under the United Nations, the development of the social sciences, the fostering of understanding between the West and the East, or the promotion of that full intercourse of minds in every field of intellectual effort upon which the advancement of knowledge depends.

The Foundation has made concrete contributions in all these fields during the year. Grants to the social sciences totalled 2,633,677 dollars, covering four primary fields. Those in the first field, of international relations, went to bodies conducting research and education designed to strengthen the foundations for a more enlightened public opinion and more consistent public policies; they included one to the Food Research Institute, Stanford University, for the preparation of a history and appraisal of the world's experience in handling food and agriculture during the War, and two grants dealing with the question of the social implications of atomic power. In the second field, of economic research, grants were made to the Economics Research Section, University of Manchester, the Department of Applied Economics, University of Cambridge, and the Institute of Economics, University of Oslo. In the third field, four or five modest grants were made in support of studies in the functioning of American political democracy; while in the fourth field, of research and training agencies, 216,000 dollars were voted to the Social Science Research Council, the Canadian Social Science Research Council and Johns Hopkins University. A final grant of 250,000 dollars was made for the erection of the giant 200-inch telescope on Mount Palomar in California, making a total appropriation of 6,250,000 dollars to the California Institute of Technology for this purpose.

Announcement of these grants, however, is not the most impressive feature of Dr. Fosdick's review. It is when he goes on to ask what is the justification for this huge expenditure of money and effort, and to discuss the implications of the unconquerable exploring urge within the mind of man, that Dr. Fosdick touches on the fundamental issues. He does not deny that knowledge is dangerous, but he insists that the answer does not lie in trying to curb science or to fix boundaries beyond which intellectual adventure should not be allowed to go. The search for truth, he maintains, is, as it always has been, the noblest expression of the human spirit. Man's hunger for knowledge about himself, his environment and the forces by which he is surrounded, gives human life its meaning and purpose, and clothes it with final dignity. Civilization is not being betrayed by science: the danger lies in the failure to use science wisely.

This is the point of view which has prompted the Foundation to extend the support of the social sciences already noted. The lack of balance in research is admitted. Our knowledge of human behaviour and social relations is inadequate to give us the guidance we need through the rapid changes in our physical environment. The fundamental issue of our time is whether we can develop understanding and wisdom reliable enough to serve as a chart in working out the problems of human relations, or whether our lopsided progress will be allowed to develop to a point that capsizes our civilization in a catastrophe of immeasurable proportions.

What is needed, Dr. Fosdick continues, is a broader basis of research, a more vigorous backing of objective and competent efforts to define and analyse the intricacies of human relationships. We need to know what our social organisation is, how it operates, and how it will react to alterations and changes. In our interdependent society, issues are no longer simple, individual and local; they are complex, social and world-wide. Our real need is a mastery not of Nature but of man's social nature, and of the social consequences of physical and mechanical advances which are shaping our lives to undesired ends.

An encouraging feature in the situation is the increasing recognition of the importance of the social services, even although it has yet to secure the necessary expansion of effort in this field. Like the Clapham Report, Dr. Fosdick insists on the importance here of disciplined minds and the high integrity of objective scholarship. We must secure a continuous flow of first-class talent into these fields, for the standard of research will depend on the quality of the men just as much as it does in the physical sciences.

But while the Rockefeller Foundation concerns itself both with the endowment of research in specific fields and with the training of men, it is equally concerned with the conditions which make research fruitful, and the appropriations of the Foundation have been distributed internationally with the purpose of breaking down the isolation and intellectual stagnation which war brings. The flow of ideas across boundary lines, the free exchange of periodicals and books, and the cross-fertilization of minds working in the same scientific and cultural fields—the interruption of these are among the tragic losses of war the magnitude of which Dr. Fosdick rightly points out is impossible to assess. We shall never know the advances which might have occurred had there been contact during these years between the biologists, the biochemists, the physiologists and mathematicians of the United States and a dozen Western European countries, or if, for example, the energy and knowledge and unselfish co-operation which were devoted to making the atomic bomb had been applied instead to some of the great basic problems of biology and medicine.

It is implicit in Dr. Fosdick's review that war interrupts and hinders the advance of science; but the review shows unmistakably the determined effort the Foundation has made to assist the resumption of research and to link up the intellectual life of Europe with that of the rest of the world. Europe is still perhaps the world's greatest power-house in terms of brains and skill, of human values and creative talent, and the grants made by the Foundation in its chief divisions—natural sciences, medical sciences, humanities, social sciences—have been designed to provide equipment and support for universities, libraries and research centres as well as to create methods of communication by which such institutions can re-establish contacts with each other and with the rest of the world, as, for example, through a series of international conferences in such fields as chemical genetics, protein structure, enzyme chemistry and cellular physiology. Into this international stream it is important to bring Russian scientific thought, and a grant has been made for that specific purpose.

Dr. Fosdick does not claim that the Foundation has been able to do more than make a very modest contribution towards the initiation of efforts to solve the great problems which Europe's intellectual needs present, and he looks very plainly to the United Nations Educational, Scientific and Cultural Organisation for the major contribution in this field. If, as Prof. L. A. Du Bridge urged in an address to the Society of the Sigma Xi and since published in *The American Scientist*, the fundamental problem is to turn the great resources of science into the paths of peace, that problem can never be solved by one country alone. Prof. Du Bridge puts the freedom of science first in his programme, and insists that no measures for extending the training of scientific workers, educating the public as to what science could contribute to the welfare of mankind, and expanding and improving the resources for research in pure and applied science, must impair that freedom; and he recognizes that fundamentally the problem of science is not national but international. Science must be applied to the specific problems of human adjustment, and the conduct of affairs be guided by the scientific method of critical examination and evaluation of actual experience rather than by raw emotion, vested authority, or prejudice, not just in one nation, but in the relations of nations with one another.

No durable world order can be established until we approach this condition, and the real hope of the Educational, Scientific and Cultural Organisation of the United Nations lies in the contribution which its work can make to that end. Therein, perhaps, is the importance of the project for the creation of the International Institute of the Hylean Amazon, now to be examined by an international scientific commission. The field work of the three scientific investigators who are going to Brazil for this purpose will constitute the first international co-operative scientific effort in a gigantic forest area, the natural resources of which, from the scientific point of view, are virtually unexplored. The proposed Institute will study the botanical, zoological, chemical, geological, meteorological, anthropological and medical facets of this area and also its potentialities as a habitat of non-indigenous peoples.

It is no disparagement of the three major projects already approved by the Executive Board of the United Nations Educational, Scientific and Cultural Organisation for 1947—an educational reconstruction programme on behalf of devastated member countries ; a campaign for the spread of fundamental education ; and the promotion of international understanding, primarily in education—to suggest that such projects as this for the Amazon basin are of outstanding importance. The demonstration in such ways of the practical contribution of science to human welfare is one of the most valuable factors in the task of educating public opinion in all countries as to the place and value of the scientific approach. It may be that the way towards world order is through the slow growth of a series of social experiments on the lines of the Tennessee Valley Authority, with its demonstration of the possibilities and effectiveness of co-operation between the expert and the ordinary citizen. But while such experiments lie outside the field of the United Nations Educational, Scientific and Cultural Organisation, that Organisation can still do much to prepare the way and to promote the conditions of success. Nor should it be forgotten that the pursuit of science for its cultural value remains worthy of man's best effort.

Science, indeed, has a contribution to make to the cultural and moral equipment of mankind as important as that of any body of literature or art. Indeed, from the point of view of world order, the contribution of science is unique. Alone of man's major intellectual interests, science has no frontiers and no national varieties ; like peace, science is one and indivisible. Dr. Fosdick's review in the annual report of the Rockefeller Foundation demonstrates admirably how science can help, unobtrusively but persistently, in the task, not merely of repairing the havoc of war and ameliorating man's material life, but also of promoting a wider understanding of human affairs, human values and motives. Upon these factors may some day be firmly based a true science of social living and a world order in which man's cultural and spiritual needs no less than his material wants find ample satisfaction.

KINETICS OF BACTERIAL GROWTH

The Chemical Kinetics of the Bacterial Cell

By Prof. C. N. Hinshelwood. Pp. x + 284. (Oxford : Clarendon Press ; London : Oxford University Press, 1946.) 20s. net.

THIS book is not a treatise or a monograph. It is an essay, in which the author has expanded the main ideas which led to his own and his group's important work on the kinetics of bacterial growth. Actually this essay has one major theme on which attention is constantly focused : the cause and mechanism of 'adaptive' variation of enzymatic properties in the bacterial cell. Indeed, the importance of the problem could scarcely be overstated, since a clear understanding of these phenomena, as they occur in bacterial cells, might throw light on basic problems in other fields of biology, such as genetics and embryology.

A large body of interesting experimental results, mostly from the author's own laboratory, has been condensed in the book, the greater part of which is concerned with the acquirement and loss of the capacity to resist drug action, or with using new sources of carbon and nitrogen. This will no doubt prove very useful for future reference.

The main object of the theoretical discussions is to see whether, and to what extent, these experimental data may be interpreted in terms of rather simple models of linked enzymatic reactions, that is, whether various types of change of properties may be considered as resulting from an 'automatic response' to a new environment. Practically all the discussions and mathematical treatment of the data are based upon one fundamental assumption, which is that each individual metabolic reaction may be represented by an equation of the type :

enzyme + substrate = more enzyme + products.

Now, the exact meaning of this equation is not altogether clear, at least at first sight, and to realize all the implications of such an assumption requires, and merits, a good deal of thought. Assuming that all the enzymes of a cell are autosynthetic structures seems to be a very bold step indeed. The fact that bacteria do grow, generally, when supplied with the necessary foodstuffs does not seem to be quite enough to justify it. It might be regretted that such an essential point should not be discussed at length, and that no *direct* experimental evidence in favour of it should be presented. (Although, in the reviewer's belief, some such evidence seems to exist, at least in a limited number of cases[1].)

However, once this postulate is accepted, interesting conclusions follow, and it is shown that the behaviour of bacterial populations submitted to new or adverse conditions can be understood as resulting from automatic adjustments of the 'enzyme balance' within each cell. The experimental data leave little doubt that this view must be essentially correct in many cases. In others, however, the evidence is far less convincing. For example, it is shown, on theoretical grounds, that prolonged 'adaptation' may conceivably lead to an *irreversible* stabilization of the new condition. This is a highly important point, as it raises the question whether such changes would be reflected in the bacterial 'genome' the existence of which seems more and more certain. Experimental proof of this point, unfortunately, appears rather doubtful, since the results might be explained just as well (sometimes much better) through the action of selection on spontaneously arising mutants.

True, the occurrence of spontaneous mutations and the importance of selection as factors of bacterial variability are discussed at some length, the general conclusion being that it seems more 'profitable' and less 'arbitrary' to consider most changes as resulting primarily from adaptive reactions, rather than from spontaneous mutations. This type of discussion is not very convincing, however. It might be argued that the 'autosynthetic enzyme' hypothesis also appears somewhat arbitrary, and that the mutation hypothesis has actually proved highly profitable in a number of important recent contributions (such as Lwoff and Audureau's work on *Moraxella*[2], Luria and Delbruck's[3], and Demerec and Fano's[4] papers on spontaneous mutations to phage resistance, Demerec's[5] work on penicillin-resistant mutants), which are not discussed.

An important chapter deals with the subject of cell division. Interesting data and interpretations are presented there, which tend to emphasize the relative independence of 'growth mechanisms' and 'division mechanism'. It is shown that, in some cases at least, each may be subject to very specific influences. This distinction undoubtedly is of great theoretical and practical importance, although it is too often overlooked.

The book ends with 'concluding observations' of a far-reaching generality, on the essential characteristics of living matter, and the possibility of understanding its origin and evolution in terms of physical forces and relations. The view is optimistic, although prudent, and it is pointed out that even the dualism of the mental and physical world may in time appear as a functional relation, the nature of which would not be very much more difficult to grasp than the relation between wave and particle, energy and matter.

J. MONOD

[1] cf. Spiegelman, *Ann. Missouri Bot. Garden*, **32**, 139 (1945).

[2] *Ann. Inst. Pasteur*, **67**, 94 (1942).

[3] *Genetics*, **28**, 491 (1943).

[4] *Genetics*, **30**, 119 (1945).

[5] *Proc. U.S. Nat. Acad. Sci.*, **31**, 16 (1945).

BRITISH FOREST TREES

Our Forests

By W. H. Rowe. Pp. 173+34 plates. (London: Faber and Faber, Ltd., 1947.) 12*s*. 6*d*. net.

THIS is the second book covering the general subject of British forestry for the non-technical reader published since the end of the War ("Forests and Forestry", by W. L. Taylor, the recently appointed director-general of forestry, being the other), and during the same period, Edlin's book on "British Woodland Trees" has also appeared. This is a very healthy sign of an increasing interest in the woodlands of Great Britain and their place in both rural and national economy. All three books are well illustrated, and Mr. Rowe has made an excellent choice of subjects. The frontispiece, taken in a New Forest roadside plantation well known to foresters, provides an ample refutation of the charge that a coniferous crop need be an eyesore, while Figs. 5 and 6 of neglected larch woods show how one may become so; the dark thicket stage shown in Figs. 21 and 22 is after all a relatively short one. It may be claimed that the bad beech of Fig. 7 has a certain attractiveness of its own, but does it surpass that of the good beech of Fig. 8 alongside? Several of the photographs reveal what excellent growth is obtainable in Britain with a number of kinds of timber tree.

The author, already known from the useful Penguin on "Trees and Shrubs", sees forestry from the private owner's point of view, but evenly distributes the blame for the past neglect of so many of our three million acres of private woodland between both the owners and the State; he would seem to favour State control over them, but by an authority separate from the Forestry Commission responsible for the State forests—an arrangement found in some Continental countries.

There are various general statements scattered through the book that need amplification or qualification. Thus we are told that ploughing complicates rather than aids planting without giving any material advantage to the trees (p. 80), that pruning increases the volume of timber (p. 94), that the pine beetle breeds in the tops of old trees (p. 104), that the alder gives the best charcoal (p. 158)—this is only true if one wants charcoal for fuses—and that European larch and Japanese larch can be mixed with satisfactory results. There is an injunction we should not care to have to carry out in dealing with honey fungus attacks, namely, digging up all the rhizomorphs, and we cannot endorse the statement that beech does not coppice well and is on the other hand very suitable for natural regeneration in Britain. There is, too, the surprising inclusion of lime among the list of materials derived from wood (p. 158). We admit to having to refer to a dictionary to find out the meaning of the word "myrobellan" hedging (p. 82), and "coda" (p. 168).

Two chapters are devoted to notes on the individual kinds of trees. It is always difficult to know what to include and what to omit in such notes; but those given in these chapters, supplemented by those for timber uses given on p. 159, will be found useful by the people for whom the book is intended, though they are sometimes incomplete to the extent even of being misleading. One might perhaps have expected to find lodgepole pine mentioned, as it is to be seen at high elevations in many plantations in Britain, and a somewhat fuller account of sitka spruce in view of its now extensive use and the remarkable rates of growth recorded under favourable conditions. The difficulty of raising silver fir as a crop should have been mentioned.

It may be said in conclusion that it is an easy book to read and should certainly fulfil the author's avowed aim of being useful and interesting to the non-expert and general reader.

H. G. CHAMPION

ADVANCED ORGANIC CHEMISTRY

A Text-Book of Organic Chemistry

By Dr. Julius Schmidt and Dr. H. Gordon Rule. Revised and edited by Dr. Neil Campbell. Fifth edition, revised and extended. Pp. xi+939. (London and Edinburgh: Gurney and Jackson, 1947.) 32*s*. net.

THE appearance of a revised edition of this well-known work only four years after the last one calls for no comment in view of the momentous events of those years, both in the world of chemistry and elsewhere; it is indeed a tribute to the zeal of Dr. Campbell that he has not been content 'to allow chemical grass to grow unnoticed'. The printers and publishers are also to be congratulated on having completed a considerable task at a time of very great difficulty, in a manner that is a credit to all concerned.

One could wish, however, that British printers could emulate those in the United States in the neatness with which structural formulæ are reproduced. A glance at the varied and elongated benzene rings, some with double bonds and some without, apparently indiscriminately, and with substituents printed in the same way as hetero-atoms, when compared with the neat regular hexagons of some modern American books, is distressing; it is only fair to point out that this untidiness is found not only in this book, but also in all British publications with which the reviewer has come into contact. The reason is doubtless that it is not easy to print regular rings except from special blocks, the expense of which would be considerable; the fact remains, however, that the American books are little, if any, more expensive, but possibly they have a larger circulation.

The general plan of the work remains as before, and it is suitable for the advanced student and research worker rather than the novice. The first hundred pages consist of a general section treating such topics as structure, isomerism, tautomerism, physical properties and nomenclature, all essential to the proper understanding of organic chemistry, but written for the most part in such a way as to be unsuitable for the beginner: a notable section describes the basic features of chromatography.

The following three parts deal about equally with aliphatic, carbocyclic and heterocyclic compounds in a systematic manner. This arrangement and its subdivisions will be well known, as there should be no one teaching or studying organic chemistry who is not familiar with the previous editions.

It is inevitable in a book of this kind that in order to cover the field in a reasonable space much of the matter should be compressed and simplified; it is perhaps a pity that in some instances such great brevity has been considered necessary, but to compensate for this, innumerable references are given which should make it very easy for any particular topic to be studied further.

The pages to which one naturally turns at present are those dealing with such substances as penicillin, paludrine, D.D.T., etc., the discovery and investigation of which have been among the few good things of the last bleak years: all such new compounds seem to be included with an adequate account of their history and properties. It is true the preparation of paludrine and the evidence for the structure of penicillin are not given, but it is probable, when the long delays in printing are considered, that neither had been published at the time the manuscript was prepared; no doubt they will be included in the next edition. Some few pages are devoted to nucleic acids.

Errors in the text are few and seem to be minor misprints; the index, of vital importance in a book of this sort, would appear to be adequate.

CARBOHYDRATE METABOLISM

Carbohydrate Metabolism

Correlation of Physiological, Biochemical and Clinical Aspects. By Prof. Samuel Soskin and Dr. Rachmiel Levine. Pp. viii+315. (Chicago: University of Chicago Press; London: Cambridge University Press, 1946.)

THIS interesting and instructive work on carbohydrate metabolism by Dr. Soskin and Dr. Levine, who have themselves contributed much of great value to the subject, is divided into five sections.

The first section deals briefly, but very clearly and adequately, with the many enzymic mechanisms involved in the chemical transformations which take place when carbohydrates break down in the living cell. The section concludes with chapters on the mode of liberation and transfer of the energy derived from carbohydrate metabolism and on the manner in which this energy is utilized for muscular contraction. The main part played by adenosine triphosphate in the reactions of the cell is emphasized, and the significance of the work of Engelhardt and of Szent-Györgyi, on the importance, for muscular contraction, of the proteins myosin and actin, is pointed out.

The second section presents considerations concerning the nature and occurrence in the tissues of substances important in carbohydrate metabolism, and discusses the origin of blood sugar and the use of the diabetic organism for the experimental study of gluconeogenesis. The next section contains a critical survey of the classical criteria of diabetes, introducing the reader to the investigations of Minkowsky, and later workers, on the dextrose–nitrogen ratio, and deals with the subject of ketosis, showing how modern views of fatty acid breakdown supplant the older theories of ketogenesis and antiketogenesis. The complicated question of respiratory quotient is discussed, and this is followed by chapters on gluconeogenesis from protein and fat.

The fourth section presents the main course of the appetizing menu provided by Dr. Soskin and Dr. Levine. This portion of the book deals with the role of the endocrine glands in carbohydrate metabolism. The mechanism of action of insulin is fully discussed, and it is evident, as the authors say, "that while we are perhaps closer to the solution of insulin action than we are to the action of any other hormone, the problem is far from solved". The influence of the pancreas, the adrenal cortex, the thyroid and the anterior pituitary glands in the control of carbohydrate metabolism is described in some detail.

The final section has to do with what the authors term the integration of physiological and clinical aspects of carbohydrate breakdown. Dextrose tolerance curves in the normal and diabetic organisms are discussed and the effects of the various endocrine secretions in blood sugar regulation are outlined. This is followed by an account of the clinical disturbances, in the endocrine control of the blood sugar, that accompany disease or dysfunction of the glands or of the liver. The book ends with a note showing how present lines of investigation indicate that it is becoming impossible to subdivide the subject of metabolism into separate compartments, there being so many substances of simple chemical structure which are common to many phases of cell metabolism. The limitations and potentialities of present lines of work in advancing both endocrinology and pharmacology are pointed out.

The book is a clear and able exposition of many of the facts of, and the modern views bearing on, carbohydrate metabolism. It is a pity, perhaps, that a little more was not said on the subject of the association between certain forms of mental disturbances and carbohydrate breakdown—a subject of great interest to the psychiatrist who has witnessed the effects of insulin shock treatment in schizophrenia, or the effects of carbohydrate in improving prolonged narcosis treatment both in psychoses and neuroses. The importance, too, of glucose in securing, under physiological conditions, the synthesis of acetylcholine in the central nervous system might have been commented upon.

The work has most useful schematic representations which help to clarify the subject-matter, and more than a thousand references. It is an excellent book which should be read by all interested in recent work on the metabolism of carbohydrates in the animal body.

J. H. QUASTEL

THE MISSING FACTOR IN SCIENCE*

By Prof. HERBERT DINGLE

Professor of the History and Philosophy of Science, University College, London

IT is now more than three hundred years since Galileo originated the process in philosophy which, in its maturer form, we now call science. This "method of philosophating", to use Salusbury's quaint seventeenth-century phrase, calls for careful scrutiny—not, at this time of day, to decide whether it has value or not, but to determine precisely what its value, its significance and its potential danger might be. One aspect of science, I think, is in general imperfectly appreciated, namely, its essentially progressive character. The motive-power behind all philosophy is the need or the desire to understand the meaning of experience, and especially those parts of experience which touch us most deeply. Accordingly, the pre-scientific philosophers took all experience for their province and aimed at producing at once a scheme of things which could comprehend the whole.

The philosophy which has come to be known as science made a radically different approach to the problem. The problem itself was the same—the interpretation of all experience; but the first requirement was certainty, not completeness. There was one department of experience in which certainty could be attained—namely, our experience of the movements of bodies. We could study these and obtain results which could be checked and confirmed. True, such knowledge was not soul-shaking, but it carried conviction with it, and on it as a basis one might mount to further knowledge, until at last it might be that the whole secret of experience would be read—not now plausibly conjectured but guaranteed as certain by its attainment through verified experience itself. And so the early men of science stopped discoursing of the origin and destiny of man and began to roll balls down slopes, to swing pendulums, and to weigh the water which dripped from a bottle. They had not necessarily a different standard of ultimate relative values from the other philosophers, but they had a different conception of how the goal could be reached.

Several consequences follow from this, of which I will mention only one—namely, that the history of science is inseparable from science itself. Science is essentially a process, stretching through time, in contrast with the instantaneous or eternal character of traditional philosophy. Scientific workers may forget the ground on which their knowledge rests; but they are not then educated men. To the true man of science they are as the artificer to the artist, the sleep-walker to the explorer, the instinctive cry to the pregnant phrase. Such a one may achieve much of value, but he is also a potential danger. At the moment he happens to be a profoundly disquieting menace to our civilization.

Let us look at this question of science and civilization, for although I believe that in its profoundest sense science is a personal philosophy and that its character as a progressive discovery of the inter-connectedness of our experience is a plant of which its present social function is a transient flower, there is no doubt that the relation of science to communal life is the question of the moment. The progress of three hundred years is indeed amazing, and its effect on our social life overwhelming. Materially, our civilization is shaped and directed by science. The possibilities in the control of life loom over us like thunderclouds, big with menace or mercy, we know not which. And scientific psychology celebrates its birth most noticeably by the generation of an army of third-rate novelists whose influence is all the more to be reckoned with because it is incalculable. In such a situation it is clear that there is no task more compellingly urgent for the sociologist than that of determining precisely what is this process which we call science; and when we contemplate the ideas of the essential nature of science which are most prevalent and operative to-day we find a situation fit to make the angels weep.

I do not say, of course, that one cannot find penetrating and worthy attacks on the problem in present-day writings, but one has to search for them. The ideas that command wide assent are not merely false but obviously false; they have only to be confronted with the most outstanding characteristics of science as it both apparently and actually is, to be recognized as such by the most elementary intelligence. I must limit myself to two examples.

"The cleavage between the scientific and the extra-scientific domain of experience," wrote the late Sir Arthur Eddington[1], "is, I believe, not a cleavage between the concrete and the transcendental, but between the metrical and the non-metrical." Thus arose, or perhaps was greatly intensified, the belief that the scope of science is limited to the measurable and its activities to the discussion of measurements. This was broadcast from pulpit and loud-speaker; it has found an echo in philosopher, in divine, in essayist, in novelist and in street-corner orator. No idea of the nature of science is more widely accepted to-day.

And yet, if one adopts the elementary, barn-door method of comparing the dictum with science itself, what does he find? As likely as not the most typical piece of scientific achievement that will occur to him will be the outstanding generalization of the nineteenth century, the theory of evolution, and if so, he can scarcely fail to notice that that theory has nothing whatever to do with measurement. It is concerned with qualitative changes alone, and is indubitably a scientific theory which changed the course of the world's thought without introducing or depending on a single measurement. And yet intelligent and learned men say and believe that science is concerned only with measurement!

My second example can be introduced by a passage which forms the starting-point of Prof. J. D. Bernal's recent consideration of the social function of science[2]. After contrasting two definitions of science—one, that it is "a pursuit of pure knowledge for its own sake", and the other, that it is "the means of obtaining practical mastery over nature through understanding it"—Bernal decides in favour of the second, and on it bases the whole of his subsequent argument. Now here again the consequences of adopting such a view are far-reaching and momentous. As everyone knows, political theories based on such a view of science are extremely active and powerful at the present time. Clearly it is worth while looking again at science as it actually is, to see if it conforms to this definition.

There are several ways in which we can do this. Perhaps the most direct and unquestionable is to look at the universal criterion by which papers submitted for publication to recognized scientific societies and journals are tested, for the essence of authentic science is contained in the publications of such agencies. And if we ask whether mastery over Nature forms any part of that criterion we see immediately that it does not. Or let us look at any examination paper for a degree in science. We shall find a large variety of questions, but none concerned with mastery over Nature. Or let us ask the "New English Dictionary", which purports to give all the commonly accepted meanings of words, what the word 'science' means. It will give us thirteen answers, but obtaining mastery over Nature is not one of them. Or let us look at the achievements for which the well-recognized prizes and medals are awarded to men of science. Again we shall look in vain for examples of mastery over Nature. After which it is perhaps superfluous to recall that the most terribly obvious characteristic of science to-day is that it is a means by which Nature seems about to master us.

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* Substance of the inaugural lecture delivered at University College, London, on June 6.

Now this phenomenon, of which I have given two examples, is extremely disquieting. That it has not aroused adequate alarm is, I believe, simply because it appears incredible and so its possibility is not entertained; but there is no doubt about it. Let us face it squarely and see what it means. It is not a matter of a few ignorant demagogues giving hasty generalizations which fail to cover minor details. Here are two distinguished thinkers, undoubtedly men of exceptional ability and deservedly held in high esteem in the scientific world, making statements of the greatest import which even an intelligent child can see to be directly contradicted by facts—not obscure facts but the outstanding, the obvious facts. And the statements are believed; and not only believed but made the basis of thought and action. The situation would be comic in some circumstances; but, standing as we do at a point in the world's history where nothing but a stark realization of facts in their naked simplicity can avail to save us, the mask of comedy drops from it and it appears tragical. What is to be done about it?

It is not my task, or within my competence, to propose an immediate course of action for the salvation of the human race, but it is my task to inquire how it has come about that a generation so amazingly proficient in the practice of science can be so amazingly impotent in the understanding of it, and the thesis I wish to propose is that the state of unselfconscious automatism in which science finds itself to-day is due to the lack throughout its history of a critical school, working within the scientific movement itself and performing the function, or at least one of the functions, which criticism has performed for literature from the earliest times. Greek tragedy, as well as its Euripides, its Sophocles, had its Aristotle; Roman poetry could show, with Horace and Virgil, a Quintilian, a Longinus. Throughout the ages there has gone, hand-in-hand with the work of the creators, the interpretation of the critics—Dante, Jonson, Dryden, Lessing, Wordsworth, Coleridge, Sainte-Beuve, Arnold—and the result, in spite of abuses, notwithstanding mutual recriminations and misunderstandings, has been that the stream of literature, without losing its momentum, has been directed, so that its power, which otherwise would have largely wasted itself in aimless dissipation, has been able to produce a cumulative effect.

We look in vain for the corresponding names in science. True, there occasionally arises a Mach, a Duhem, a Pearson, but they are conspicuous by their scarcity, and few heed them. The great bulk of the critics of science have not been within the scientific movement, and their aim has been in the main not so much to understand as to discredit it. The one-sidedness, the blindness, the coldness of science have been preached *ad nauseam*, and the men of science themselves, if they have looked up from their work to notice the attacks at all, have been contented with a half-hearted defence, satisfied for the most part to be obviously doing something without caring to define even to themselves what their activity means. Science has thus progressed like a ship with an all-powerful engine and no compass or rudder or steersman, measuring its progress in knots and not in terms of approximation to a desired haven, while its only 'guidance' has come from airmen overhead who, knowing nothing of its nature and potentialities, shriek their conviction that it will never reach the stratosphere.

It is not difficult to see how this lamentable difference between science and literature has arisen. Literature in its naked simplicity has no intrinsic standards, and was thus led by necessity to become self-critical. But science *has* intrinsic standards. A scientific statement must, directly or indirectly, express experience and be subject to the test of experience. If the expression is indirect, the connexion must be rational. These requirements have been satisfied by men of science with a consistency and purity of practice that is not even approximately equalled in any other large-scale human endeavour; that is why science has made such astonishing progress in so short a time. Over its terrain of rocks and quicksands science walks as sure-footed as a mule—and as sapient. It has no need of standards of judgment and so has produced no critical school, but by this omission it has lost the other and greater benefit which such a school can give—namely, that of surveying, describing and interpreting the movement itself. That is why it can combine such brilliancy of achievement with such obscurity of understanding.

A critical effort within science can perform at least two necessary functions. It can direct the movement itself, so that blind alleys are avoided and the path of progress illuminated; and, still more important for the world as a whole, it can make science self-conscious and aware of the significance of what it is doing in relation to other human activities. This cannot be done effectively from outside; it is only within the world of science that the necessary knowledge exists. It is no small calamity, therefore, that that world, with some honourable exceptions, is so indifferent to the attempt to understand and interpret its own activities. It makes no provision for recognizing and encouraging such an endeavour. Let me throw one sidelight on this, to reveal the general position. Sir Arthur Eddington spent the later years of his life in developing a theory of the fundamentals of physics which has met with little response because of the difficulty of understanding what it is all about. Nevertheless, it contains such an impressive wealth of agreement between theory and observation that it is impossible any longer to doubt that the theory contains something of the most profound significance. Both the intrinsic value of the theory and the illegitimacy of at least part of Eddington's exposition of it appear unquestionable.

Now let us imagine a thinker whose powers of penetration enable him to pierce through the obscurities of Eddington's diction to the underlying truth;

to realize also, with equal clearness, the more orthodox points of view of Einstein, Bohr, Dirac and others; to see wherein the outlooks differ and how they can be reconciled; and to re-express the work of all in terms compellingly obvious, so that the contribution of Eddington can be assessed at its true value and physicists everywhere united on a common front in an immensely strengthened position for apprehending and solving the problems that remain. There can be no doubt, I think, that such a man would render to physical science the greatest benefit possible to it at the present time; yet the world of physical science has no provision for acknowledging such a benefit. For slightly inferior intellects there are Copley Medals, Orders of Merit, Nobel Prizes and the like, but for him, nothing. Like Bunyan's Interpreter, he makes pilgrimage possible, and is heard of no more. He has added nothing to knowledge; he has not discovered a single new fact of observation or revealed a single relation between measured quantities or introduced a single new concept into the subject. Everything of that kind has been done by others before him; he has simply brought to light what they have done. I submit that a condition in which clear-sighted understanding is esteemed so lightly in comparison with blind achievement is not one which ought to be regarded without misgiving.

If we try to look into the immediate future the misgiving grows. We are about to experience a great increase of scientific activity. Existing universities are to be enlarged and new ones created, and we may look forward to a rapidly growing army of young workers, becoming more and more specialized as time goes on. Competition for entry to the Royal Society will be greatly intensified, and since entry is to be gained by doing things and not by knowing what one is doing, those who pause to reflect on the meaning of their work will fall behind in the race and remain outside. At the present time the Royal Society contains, chiefly among its older Fellows, some—though far too few—who have been able and willing to supplement their specialized work by giving attention to its wider implications. Through their labours and those of their forerunners the Society has supported research into the nature and history of science in various ways, for which we cannot be too thankful. But such efforts will almost inevitably decrease, and while I do not believe that the race of historians or philosophers of science will die out, the conditions of the time will be such that they will be automatically segregated. Instead of a vigorous critical school growing up within and promoting the welfare of science, we are likely to have an artificially stunted one growing up without and conflicting with it. Such a prospect bodes little good either for science or for the community as a whole.

What are the omens on the other and brighter side? Apart from the sporadic and incalculable influence of exceptional individuals, I know of only one. I said just now that our hypothetical interpreter of modern physics could receive no recognition of his service. I was wrong. If he cared to fulfil certain other conditions well within his scope, he could earn an M.Sc. degree of the University of London in the history and philosophy of science. That may seem something of an anti-climax, and if that aspect of it should tend to direct someone towards a rectification of the situation I would not wish to temper the feeling, but it is not the aspect I want to present now. The Department of History and Philosophy of Science at University College was founded in 1923. During the sixteen years prior to its suspension at the outbreak of war, 173 students, all graduates in science, took its courses, and 84 M.Sc., 18 Ph.D., and 2 D.Sc. degrees were awarded. In the first and second year since revival, 10 and 37 students, respectively, have been enrolled. From the first the courses were planned on admirable lines, and the foundations of a uniquely valuable Department have been laid. The staff, originally comprising one part-time teacher, has grown to four full-time and one part-time teachers, with assistance from other teachers of the University who have special knowledge of the history of their own science. The University, fully aware of the need for such a Department, has given it high priority in the forthcoming expansion. It needs now but the devoted and efficient service of its members to realize at least some of the high hopes that went to its establishment.

The fact that, by the award of higher degrees within the Faculty of Science, a great University recognizes the attainment, by those trained in the practice of science, of some understanding of what they have been practising has, I think, an importance out of all proportion to the present magnitude of the effort. However inadequate it may be, its influence is genuine. It begins to create within the scientific world an atmosphere in which true science, become self-conscious, can flourish and spurious science decay. As the community is called upon to consider how it is to adjust itself to a world in which the influence of science grows ever greater, it infuses into society a leaven of men and women who are not deceived by the momentary appearance of a movement which, after taking two thousand years to prepare itself, has been gathering momentum for the last three hundred years. The example of London may in time be followed by other universities until gradually the critical spirit becomes an integral part of science everywhere, and the mad rush along the primrose way to the everlasting bonfire is changed to an ordered movement towards a preconceived and deliberately chosen goal. Provided that the effort has not come too late, it may well prove in the end to have started the process which will convert science from a mysterious menace to a comprehended blessing. Such, at any rate, is its potentiality; it remains to make it actual.

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[1] "The Nature of the Physical World", by Sir Arthur Eddington, p. 275.

[2] "The Social Function of Science", by J. D. Bernal (Routledge, 1939).

THE SPARK DISCHARGE

A DISCUSSION on "The Spark Discharge" was held at a meeting of the Physical Society in the Physics Department, Imperial College of Science and Technology, London, on April 23. The opening paper was presented by Prof. L. B. Loeb, of the Physics Department, University of California, Berkeley. Other invited speakers were Prof. J. M. Meek and Dr. T. E. Allibone.

In a survey of certain aspects of the mechanism of development of spark discharges, Prof. Loeb made particular reference to the distinctions between the Townsend theory of the spark and the streamer theory of the spark, as proposed by Loeb and Meek. The Townsend theory is now considered to apply only to the breakdown of short gaps in gases at low gas pressures, whereas the streamer theory applies to the breakdown of gaps of the order of 1 cm. or more at about atmospheric and higher pressures.

According to the Townsend theory, the breakdown of a gap occurs when $\gamma e^{\alpha d} \doteqdot 1$, where α is the number of pairs of electrons and positive ions created per centimetre in the direction of the electric field by a single electron, γ is the chance that a positive ion striking the cathode will liberate a secondary electron, and d is the gap-length. This expression enables the breakdown voltage of a gap to be determined from the known measured values of α and γ as functions of voltage gradient and gas pressure. As in individual cases the values of $e^{\alpha d}$ and γ fluctuate considerably about their mean measured values, variations in the breakdown voltage may be expected to occur. Prof. Loeb showed that the resulting relation between the applied voltage and the probability of a spark is in agreement with experimental observations of the time-lags to breakdown, and also establishes the basis for the correct evaluation of the threshold sparking voltage. Further, an expression can be deduced to relate the total observed time-lag with the formative and the statistical time-lags.

The streamer theory involves the same quantity $e^{\alpha d}$ in conjunction with a new parameter γ^1, analogous to the Townsend γ, but depending on photon production in the head of an electron avalanche, and the photon absorption in the high-field region surrounding the avalanche head. Here again an expression can be deduced for the observed time-lag of spark development in relation to the statistical and formative time-lags, and Prof. Loeb stressed the need for further experimental measurements of these quantities, particularly in order to determine the transition between the Townsend and the streamer mechanism.

The Townsend mechanism depends on the numbers of ions in the gap and is in agreement with Paschen's law, which states that the voltage required to cause breakdown of a uniform gap is a function of the product of gap-length and gas pressure. Meek's criterion for a spark, as based on the streamer mechanism, depends on the ion concentration in an individual electron avalanche, and predicts small deviations from Paschen's law. This anticipated failure of Paschen's law has been confirmed by recent measurements of the breakdown of uniform fields at high voltages, for wide ranges of gap-length and gas pressure, and Prof. Loeb showed that the experimental results accord in principle with those expected from Meek's theoretical calculations.

The streamer process develops across the gap to form an ionized path or spark channel through which the external circuit discharges. The breakdown of the gap is then complete, and the voltage between the electrodes falls to a considerably reduced value corresponding to the voltage drop along the spark channel. Prof. Meek described some of the results obtained by Mr. J. B. Higham and himself in investigations of the voltage gradients and current densities in spark channels for gaps up to 100 cm. in length in air and other gases. The various parameters are recorded either oscillographically or by photographic methods. In one of the records shown, for a spark in air carrying 100 amp., the voltage gradient at a time 1 microsec. after breakdown is 120 volts per cm., and at 50 microsec. is 25 volts per cm. These values of voltage gradient are considerably greater than those for continuous arcs carrying the same current. Measurements of the spark diameter show that the channel expands during its early stages at a speed of the order of 10^5 cm. per sec., in accordance with the results obtained by Flowers. The current density in the channel is initially of the order of 10^5 amp. per cm.^{2}, but it decreases rapidly and, for a 400-amp. spark in air, is about 2×10^4 amp. per cm.^{2} at a time of 1·3 microsec. after breakdown. Some records have been obtained for sparks in which the growth of the channel is restricted by a surrounding glass tube. Other records were described for sparks in liquids; in one oscillogram shown, for a 250-amp. spark in water, the voltage gradient measured at a time 1 microsec. after breakdown was 1,200 volts per cm.

Prof. Meek stated that in the measurements of current density the values given are determined on the assumption that the current is evenly distributed over the cross-sectional area of the spark. It is probable, however, that there are radial variations in the current density, and that the ion density and the current flow may be slightly higher near the centre of the spark than near the circumference. A further feature of spark channels is that emission of light persists for much longer times in certain parts of the channel than in others, so that the channel appears to break up into a series of discrete small regions of luminosity, in the manner similar to that of the occasionally observed phenomenon of 'bead lightning'. Prof. Meek referred to investigations of this persistence of luminosity which are now being made by Craggs and Hopwood.

The investigations by Schonland and his colleagues into the mechanism of development of lightning discharges were described by Dr. Allibone. By means of photographs obtained with a rotating film camera, Schonland has shown that the first stroke of a lightning discharge in open country is preceded by a streamer process known as a 'stepped leader stroke', which develops in a series of steps from cloud to ground at a speed of about $1{\cdot}5 \times 10^7$ cm. per sec. When the leader stroke reaches ground, the main stroke travels up the pre-ionized channel which has been established between the cloud and the ground at a speed of the order of one tenth that of light. The large currents observed in lightning discharges flow during the passage of the main stroke. The second and subsequent strokes of a lightning discharge are each preceded by a 'dart leader stroke', which usually proceeds in a single flight from cloud to ground, at a speed of about 2×10^8 cm. per sec., and follows the track traced out by the first stroke. After each dart leader there is a main stroke which develops from ground to cloud.

Rotating-camera studies have also been made for long spark discharges in the laboratory by Allibone and Meek, who have shown that considerable differences exist in the mechanism of development of long spark discharges in non-uniform fields between a point and a plane according to the polarity of the discharge. In a gap between a positive point and an earthed plane, a leader stroke develops from the positive point to bridge the whole gap, and the main stroke then takes place along the path traced out by the leader stroke. For a negative point and an earthed plane, the discharge is initiated by a negative leader stroke developing from the point; but, after this leader stroke has grown for only a short distance into the gap, a positive leader stroke develops from the earthed plane and the two leader strokes proceed towards each other to meet in the mid-gap region. The breakdown is completed by the passage of the main stroke along the track pre-ionized by the leader strokes. Considerable differences are observed in the characters of the positive and negative leader strokes. The positive leader stroke develops usually in a continuous manner, though steps occur when a high series resistance is included in the circuit, and these steps become more pronounced with decreasing gas pressure. The negative leader stroke develops in a series of sharply defined steps, and is accompanied by a considerable number of mid-gap streamers.

In all three papers it was evident that, although the various modern techniques of high-speed recording have yielded a considerable amount of experimental data concerning the development of spark discharges, there are still many aspects of the problem requiring further investigation. Also, while the mechanism of spark breakdown in uniform fields can now be explained in terms of fundamental processes, the interpretation of all observed sparking phenomena, particularly in non-uniform fields, is still by no means complete.

TATA INSTITUTE OF FUNDAMENTAL RESEARCH

IN India, where the number of institutions for research is very small, it is now keenly realized that much greater attention must be paid to research, pure as well as applied, if India is to keep pace with the progressive nations of the world. A result of this new outlook and a welcome addition to such institutions is the newly established Institute for Fundamental Research, sponsored by the trustees of the Sir Dorabji Tata Trust and the Government of Bombay, with the subsequent support of the Government of India. The object is to create a centre for fundamental research, with particular reference to atomic physics and mathematics, and also to train the young scientific workers of India in these subjects.

Tatas, the biggest industrialists of India, have a long tradition of foresight and wisdom in the employment of their resources. To-day, 85 per cent of their capital is held in public trusts for benevolent projects, chief among which is the promotion of higher education and research. They were the pioneers in founding the Indian Institute of Science at Bangalore, the Tata Memorial Hospital for cancer and the Tata Institute of Social Sciences at Bombay. The Tata Institute of Fundamental Research is the newest institution which owes its existence to their enterprise and munificence.

Since 1942, the Sir Dorabji Tata Trust has supported a Cosmic Ray Research Unit headed by Prof. H. J. Bhabha, F.R.S., at the Indian Institute of Science, Bangalore. It was felt, however, that the modern demands of fundamental research in cosmic rays and nuclear physics could only be met by means of a separate institute devoted entirely to these subjects. The Cosmic Ray Research Unit of the Indian Institute of Science was moved to Bombay in 1945, and formed the nucleus around which the new project was built. As the construction of new buildings was not possible during the War, the Institute was housed in temporary premises. It was formally opened on December 19, 1945, by Sir John Colville, Governor of Bombay.

On that occasion, when inaugurating the Institute, Sir John Colville said: "India stands in urgent need of the speedy development of her resources, both agricultural and industrial. This can only be achieved with the aid of science. For modern industry and agriculture rest, to an ever-increasing extent, upon scientific foundations, and economic progress depends on continual advances in the field of fundamental research which provides the material on which the applied scientist can work." Sir John Colville further remarked that: "Applied research, designed to meet the practical needs of industry and agriculture, and carried on in the laboratories of Government research stations or by particular firms, is necessary. It is, however, increasingly recognized that research of a fundamental character, not directed towards specific practical objectives, is of vital importance, because of its fructifying and stimulating influence on applied research, which, without it, is bound to languish. Applied research, in fact, must be kept constantly refreshed by contact with the original work of the pure scientist."

During the first year of its existence it became clear that the new Institute would have to expand rapidly, and the necessary funds for this expansion were sanctioned by the Government of India through the Council of Scientific and Industrial Research. The Institute is to-day administered by an independent council on which the Government of India, the Government of Bombay and the trustees of the Sir Dorabji Tata Trust are represented. At present the Institute has chairs of theoretical physics, experimental physics, pure mathematics and astrophysics. Provision is also made for a visiting professorship so as to enable the Institute to invite distinguished men of science from abroad to work in the Institute for a year at a time. The Institute has also several readerships, and posts for research fellows and research assistants. A number of students are given liberal stipends to enable them to work under the professors of the Institute.

Since its start, the Institute has completed an experiment for measuring the intensity of the penetrating component of cosmic rays up to an altitude of 40,000 ft. In this experiment the intensity of cosmic rays penetrating 30 cm. of lead was measured for the first time up to these altitudes. Several papers on the theory of the elementary particles and on new relativistic wave equations, on mathematical and statistics topics, have been published by members of the Institute.

The Institute will encourage to the utmost the exchange of scientific ideas. Recently a group of foreign men of science visited India as delegates to the Indian Science Congress, and the opportunity was taken to invite Prof. P. M. S. Blackett, of the University of Manchester, Prof. J. Hadamard, of the Institut de France, and Prof. S. S. Chern, of the Academia Sinica, as visiting professors to the Institute to deliver courses of lectures on their subjects.

The Council of Scientific and Industrial Research has decided that the Institute shall be the centre of all large-scale research in nuclear physics in India, and has sanctioned a scheme for the setting up, at the Institute, of a high-energy accelerator, capable of producing particles of energies up to 200 MeV. A team of ten investigators is being formed for this purpose. With the establishment of the high-energy accelerator, it is intended to lay down a long-range plan of nuclear research.

It is also likely that a small atomic pile will be set up at the Institute in the near future, which will provide further facilities for research in atomic physics, and also for the production of tracer elements. The scope of the work of the Institute will then be enlarged by the addition of departments for nuclear chemistry and nuclear biology.

A further series of experiments to measure the intensity of cosmic radiation at high altitudes and at great depths is also being planned, and it is intended to undertake these experiments soon.

The Institute is at present housed in temporary premises, but suitable buildings will be provided as soon as possible. The site chosen for the permanent buildings faces the picturesque harbour of Bombay, and is about a mile away from the heart of the city. It is proposed to undertake immediately the construction of two blocks of buildings, one for theoretical work, instruction and administration, and the other for experimental work on cosmic rays. The plans of these buildings will be so designed as to allow for the construction of additional blocks for nuclear physics and for housing the high-energy accelerator and its auxiliaries. The buildings will be completely air-conditioned and fitted with the latest equipment.

With the expansion of the activities of the Institute, the sponsors of the Institute believe that it will become an important centre of research in India within the next few years.

MECHANISM OF ENZYME SPECIFICITY IN THE DOMAIN OF CARBOHYDRATES

By Dr. A. GOTTSCHALK

Walter and Eliza Hall Institute of Research in Pathology and Medicine, Melbourne

It would appear that it is the function of enzymes to reduce the energy of activation for a given reaction. How this is effected is at present unknown. There is, however, consensus of opinion that enzyme action is initiated by a union between enzyme and substrate. Bergmann[1] has advanced the theory that the enzyme protein by virtue of polar groups arranged in a pattern at its surface makes a multipoint contact with corresponding polar groups of the substrate. An intimate relationship of this kind between the interacting groups, suitably arranged in space, of enzyme and substrate may be regarded as the material basis of enzyme specificity. In most cases a single enzyme reacts with a group of substrates, though at different rates; in some cases, however, the activity of the enzyme is directed towards one substrate only. The degree of specificity of an enzyme may most properly be expressed by the decrease in the reaction velocity caused by a change in the constitution or configuration of that substrate acted upon with the highest reaction velocity (at various substrate concentrations). During the last fifteen years the effect of constitutional and configurational changes in hexoses and their glycosidic derivatives on the activity of the enzyme concerned has been extensively investigated. In view of the results of these investigations, it seems possible to derive some principles underlying enzyme specificity in the field of carbohydrates and in some instances to mark precisely the atoms or groups of the substrate which are involved in the bonding with the receiving groups of the specific enzyme protein.

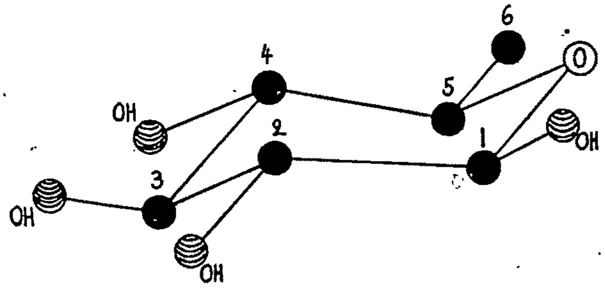


Fig. 1. BETA-GLUCOPYRANOSE (SACHSE TRANS-RING)

According to recent results[2,3] the pyranose ring of *d*-glucose is of the Sachse trans (chair-shaped) form, inter-atomic distances and angles being normal within the limits of experimental error (cf. Fig. 1). In beta-*d*-glucopyranose the carbon and oxygen atoms lie in two parallel planes 0·5 A. apart, while in beta-*d*-mannopyranose the oxygen atom attached to C_2 projects about 1½ A. from the mean plane of the ring. There is rotation about the C_5-C_6 single bond, probably restricted by an energy barrier due to the attractive and repulsive forces of neighbouring groups.

Most likely the free or substituted hexose molecules approaching the enzyme will orientate themselves with the mean plane of their ring parallel to the surface of the enzyme protein, because this will provide for the greatest development of van der Waals forces between the enzyme and substrate molecules. We assume that by hydrogen bond formation or electric dipole interaction the enzyme comes into contact with at least two groups of the hexose molecule (or hexose residue), including the one which is changed in the catalytic reaction. There can be little doubt that with glycosides as substrates the oxygen atom of the glycosidic linkage is involved in the contact with an appropriate group of the enzyme protein; indeed, the reverse reaction, the enzymatic synthesis of methyl-beta-*d*-glucoside from beta-*d*-glucopyranose and methanol is scarcely conceivable without contact being established between the enzyme protein and the two hydroxyl groups the interaction of which results in the formation of the glucosidic linkage. Moreover, evidence was recently presented[4] suggesting that the enzymatic conversion into *d*-fructofuranose-6-phosphate of the alpha- and beta-forms of *d*-glucopyranose-6-phosphate and of *d*-mannopyranose-6-phosphate is catalysed by two individual hexose-phosphate isomerases. The existence of a specific mannose-6-phosphate isomerase as distinct from the glucose-6-phosphate isomerase is to be expected; for, on the above assumptions, the conversion into a common isomeride of two stereoisomeric hexose derivatives differing in the configuration at a single asymmetric carbon atom cannot be catalysed by the same enzyme. In their association with the respective enzymes, therefore, beta-hexosides (Fig. 2) are orientated with their upper side towards the surface of the enzyme protein, whereas alpha-hexosides (Fig. 4) face the enzyme with their underneath side. The primary alcohol group, due to the restricted rotation of C_6, may be able to face the enzyme irrespective of whether the upper side or the reverse side of the glucose molecule is orientated towards the catalyst.

In a series of thorough investigations, Helferich[5], Pigman[6], Weidenhagen[7], Hudson[8] and Hofmann[9] have studied the specificity requirements of the various

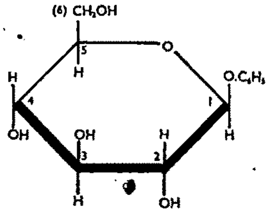


Fig. 2. PHENYL-*β*-*d*-GLUCOSIDE.

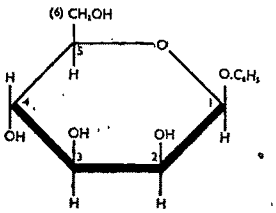


Fig. 3. PHENYL-*β*-*d*-MANNOSIDE

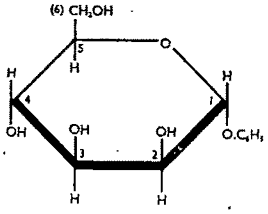


Fig. 4. PHENYL-*α*-*d*-MANNOSIDE.

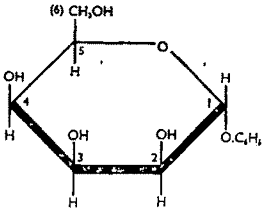


Fig. 5. PHENYL-*α*-*d*-TALOSIDE

glycosidases. It was shown that a change in the configuration at one or more ring carbon atoms or a change from the pyranose to the furanose structure renders a hydrolysable glycoside unhydrolysable by the same enzyme; for example, beta-glucosidase does not split phenyl-beta-*d*-mannoside (Fig. 3), and alpha-mannosidase is inoperative towards phenyl-alpha-*d*-taloside (Fig. 5), though these compounds differ from the specific substrates phenyl-beta-*d*-glucoside (Fig. 2) and phenyl-alpha-*d*-mannoside (Fig. 4) only in the configuration at C_2 and C_4 respectively. The effect of substitution is a different one. Thus, substitution in phenyl-beta-*d*-glucoside (Fig. 2) of the hydroxyl group at C_6 by H, F, Cl, Br or OCH_3 affects only the rate of hydrolysis by beta-glucosidase, a linear relationship obtaining between the volumes of the substituents and the logarithms of the enzyme efficiencies. Phenyl-beta-*d*-glucoside-3-methyl-ether (Fig. 6), however, is not hydrolysed by beta-glucosidase; the same holds for thiophenyl-beta-glucoside, in which compound the glucosidic linkage is effected by sulphur instead of by oxygen. Alpha-mannosidase splits phenyl-alpha-*d*-mannoside (Fig. 4) and, at much lower rates, phenyl-2-desoxy-alpha-*d*-mannoside (Fig. 7) and phenyl-alpha-*d*-lyxoside, the latter containing the alpha-*d*-manno-pyranose ring with the side chain —CH_2OH substituted by H.

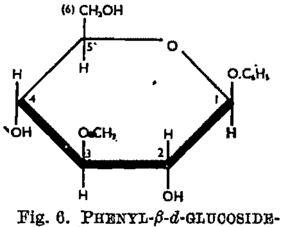


Fig. 6. PHENYL-*β*-*d*-GLUCOSIDE-3-METHYL-ETHER

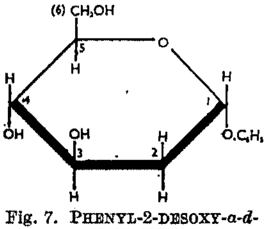


Fig. 7. PHENYL-2-DESOXY-*α*-*d*-MANNOSIDE

These results suggest that in beta-*d*-glucosides and in alpha-*d*-mannosides, besides the oxygen atom of the glycosidic linkage, only the hydroxyl groups attached to C_3 (beta-glucosides) and to C_4 (alpha-mannosides) respectively are available for contact with the enzyme protein. Concerning the bonding between the aglycon part of the glycosides and the enzyme, nothing definite can be said. It may be pointed out that in evaluating the results of substitution experiments it has to be borne in mind that the substituent group does change not only the molecular volume of the substrate but also the effective amount and the distribution of electric charge in the molecule. This may account for the observation that the 2, 4, 6-trimethyl derivative of phenyl-beta-*d*-glucoside does not react with beta-glucosidase (cf. also Pigman[9]).

The enzyme phosphoglucomutase, discovered by Cori *et al.*[10], catalyses reversibly the intramolecular shift of the phosphate group of alpha-*d*-glucopyranose-1-phosphate (Fig. 8) from C_1 to C_6, thus changing the glucosidic compound into glucose-6-phosphoric ester. As this enzyme does not act on alpha-*d*-mannose-1-phosphate or alpha-*d*-galactose-1-phosphate[11], which compounds have a reverse configuration at C_2 and C_4 respectively, we may assume that besides the glucosidic oxygen and the primary alcohol group at C_6, the —OH groups at C_2 and C_4 take a direct part in, or exert a decisive influence on, the association of the substrate with the enzyme.

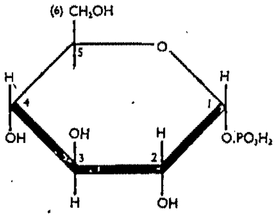
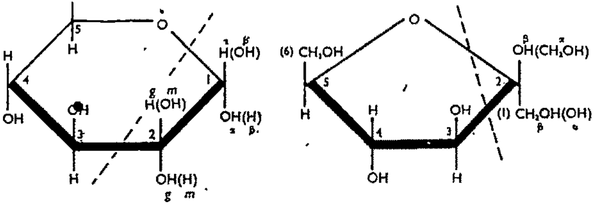


Fig. 8. *α*-*d*-GLUCOPYRANOSE-1-PHOSPHATE

The first step in alcoholic fermentation by yeast of *d*-glucose, *d*-mannose and *d*-fructose is interaction between the mobile phosphate group of adenosine triphosphate and the primary alcohol group of the individual hexose. The common catalyst of this reaction is the enzyme hexokinase[12]. It has been established in recent years that *d*-glucose and *d*-mannose are fermentable in their alpha- and beta-pyranose forms, whereas *d*-fructose is suitable for fermentation only in its furanose form[4,13-16]. In contrast to the specificity requirements of glycosidases, hexokinase tolerates rearrangements of the atoms and groups attached to the asymmetric carbon atoms 1 and 2 of *d*-glucopyranose, and moreover the fundamental change from the pyranose to the furanose structure. The alpha- and beta-modifications of *d*-glucopyranose, *d*-mannopyranose and *d*-fructofuranose have as a common feature the same side-chain and the same configuration at C_3, C_4 and C_5 (Fig. 9 *a*, *b*). Obviously only groups of the structural pattern common to the various substrates of hexokinase can be involved in the enzyme-substrate contact; therefore, the attachment groups of the substrate may be either the —OH groups at C_3 and



(*a*) (*b*)

Fig. 9. SHOWING THE IDENTICAL CONFIGURATION AT C_3, C_4, C, AND THE IDENTICAL SIDE-CHAIN ATTACHED TO C_5 IN THE *α*- AND *β*-FORMS OF *d*-GLUCOPYRANOSE (*ag*), *d*-MANNOPYRANOSE (*am*) AND *d*-FRUCTOFURANOSE (*b*)

C_6 or those at C_4 and C_6. A decision between these alternatives seems possible on the following reasoning. Glucose oxidase (from *Aspergillus niger*) catalyses the oxidation of *d*-glucose to gluconic acid, and at a much lower rate (1/4) it also oxidizes *d*-mannose[17]. Since in this case the hydroxyl at C_1 is one of the attachment groups, it may be concluded that a change in the configuration at a carbon atom adjacent to that carrying a contacting group greatly affects the velocity of the enzymatic reaction. Further examples supporting this conclusion can be easily presented. The hexokinase reaction with *d*-mannose as substrate proceeding only at about one third of the rate of its reaction with *d*-glucose[18], the addenda to C_2 appear to be vicinal to one of the contacting groups. Hence, the —OH groups of the substrate interacting with the receiving groups of hexokinase most probably are those at C_3 and C_6.

It would thus appear that the specificity of enzymes acting on hexosides resides in some atomic groupings arranged at the surface of the enzyme protein in a pattern able to attract the hexose residue by the glycosidic oxygen and one or more hydroxyl groups in *cis*-position to this oxygen. In addition to this bonding, attraction must be assumed for one or more groups of the aglycon part of the glycoside. Thus, the substrate molecule as a whole is appropriately orientated and fixed. The activity of glycosidases is restricted to a single type of the aldo-pyranose ring, because any change in the configuration at a ring carbon atom may remove from its proper spatial position a contacting —OH group, or produce a steric hindrance by replacing a hydrogen atom with the more voluminous hydroxyl group, or result in such a redistribution of electron charge as to eliminate the possibility of bonding between the respective groups of enzyme and substrate. There are, however, enzymes acting on hexoses, for example, hexokinase, which are less sensitive to configurational changes in the substrate. The quantitative effect on the enzyme-substrate relationship of a change in configuration at an asymmetric centre depends mainly on the spatial relation of the latter to the contacting groups. A rearrangement of the hydrogen and hydroxyl group at a carbon atom adjacent to an attachment group of the substrate invariably affects seriously the rate of the enzymatic reaction. When, however, the same configurational change takes place at a carbon atom more distant from the contacting groups, the effect on the enzyme-substrate relationship is much less marked.

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OBITUARIES

Prof. C. A. Kofoid

LESS than two months after the death of H. S. Jennings (see *Nature*, June 21, p. 834), America has lost another—and almost the last—of her elder workers on the Protozoa. Prof. C. A. Kofoid died—also in California—after a heart attack on May 30 at the age of eighty-one.

Charles Atwood Kofoid was born at Granville (Illinois) on October 11, 1865, and took his first degree (A.B.) at Oberlin College in 1890. He then moved to Harvard, where he graduated A.M. (1892) and Ph.D. (1894). After a short period of teaching at Michigan (1894–95), he was appointed superintendent of the Illinois Biological Experiment Station, where he remained for five years. Finally, he gravitated to the centre of his chief scientific activities—the University of California, where he became assistant professor of zoology in 1900, and professor and director of the department in 1910. He remained at this post for more than a quarter of a century, when he retired (1936) as professor emeritus.

Kofoid was a zoologist of wide interests, but devoted his great energies particularly to marine zoology, protozoology, and parasitology. He was always attracted by planktonic organisms, and while at Illinois published papers on the phytoflagellates of the Illinois River. Later, at California, he took a leading part in establishing the Marine Biological Station (now the Scripps Institution of Oceanography) at San Diego, and produced a notable series of memoirs on the dinoflagellates of that region. These were followed by exhaustive systematic monographs on the Unarmoured Dinoflagellata (with O. Swezy, 1921), the Dinophysoidæ (with T. Skogsberg, 1928), the Tintinnidæ (with A. S. Campbell, 1929), and the Heterodiniidæ (with A. M. Adamson, 1933). Earlier, he published a detailed survey of all "The Biological Stations of Europe" (1910). In the field of applied zoology, with which he was always concerned, he played an active part on various committees for studying the damage done by the shipworm (the mollusc *Teredo*: reports published in 1924 and 1927), and also that caused on land by termites (final report published in 1934); and with his pupils he paid much attention to the wonderful flagellate Protozoa living in these remarkable insects.

Towards the end of the First World War Kofoid was appointed major in the U.S. Sanitary Corps, and threw himself with enthusiasm into the study of human intestinal Protozoa. A long series of papers by himself and his collaborators was the result. But unfortunately, he approached this intricate and tricky subject without sufficient previous experience, and consequently most of his 'discoveries' and all his 'new' genera and species are now known to be misinterpretations. To the end of his life, however, he refused to give them up. In his later years he also became interested in the history of biology, and during the last decade wrote many reviews for *Isis*. He left a large library, which is housed in the University of California at Berkeley.

Kofoid will be specially remembered for his fundamental share in developing the Zoology Department of the University of California to its present distinguished status, and for his editorial work in connexion with the "University of California Publications in Zoology". These contain many important papers—including many by himself and his pupils—

which are familiar to all zoologists. His own publications are too numerous to mention in more detail, but together they constitute an integral part of the output of protozoological research in the United States during the last fifty years.

CLIFFORD DOBELL

Prof. A. W. Stewart

EMERITUS PROF. ALFRED WALTER STEWART died at his residence in Belfast on June 30, after many years of indifferent health borne with stoical courage.

The youngest son of the late Prof. William Stewart, Dean of Faculties in the University of Glasgow, he was educated at the University of Glasgow, the University of Marburg and University College, London, and had held in turn the lectureship in organic chemistry at Belfast and the lectureship in physical chemistry and radioactivity at Glasgow. In 1919 he succeeded the late Prof. Letts as professor of chemistry at Belfast. During his tenure of office in Queen's University, Stewart did much to create the school from which many of his students went to occupy important positions in industrial and academic life at home and abroad. He was a man of great learning, gifted with a fertile imagination, and laboured continually to provide a sound and fundamental training in all branches of modern chemistry. He was ever ready to give counsel to those who sought his advice, and was deeply interested in the welfare of his students.

Stewart had a special interest, born from his close association with Ramsay and Collie, in the application of physical chemistry to the elucidation of the structure and properties of organic compounds, and his work upon Tesla-luminescence spectra was especially noteworthy. He and his co-workers developed a new field of spectroscopy by employing a fresh method of excitation to reveal series of spectra each of which is characteristic of the compound which emits it, and so added a new constitutional property to those previously known.

His love of investigation and his interest in the teaching of chemistry are revealed in his many writings, notably the volumes in his series of "Recent Advances in Physical, Inorganic and Organic Chemistry", which have reached many editions. He had pleasure in recalling that he had directed attention to the elements which had identical atomic weights but which differed in chemical properties and to which he gave the name 'isobars'. Since his retirement in 1944 from the chair of chemistry in the Queen's University of Belfast, which he had occupied for twenty-five years, he had devoted himself to his literary work with increased pleasure and devotion.

To have been one of Stewart's intimate friends is a privilege and a cherished memory; of a shy and retiring disposition, he avoided all forms of ostentation, and only those who had his confidence can appreciate the kindly nature, the tender affection and the stimulating effect of an evening spent with him by his fireside. Stewart's work—both as a man of science and an author—was characterized by meticulous care and thoroughness. His interests were catholic and his learning wide. British science is poorer by his loss, and another link has been severed with the pioneers of the early years of this century.

During his years of ill-health, borne with great fortitude, he had the constant companionship of his wife and only daughter, to whom sympathy is extended in their loss.

D. N. MCARTHUR

Prof. G. E. M. Jauncey

DR. GEORGE ERIC MACDONNELL JAUNCEY, professor of physics at Washington University, St. Louis, Missouri, died on May 19 at his home in St. Louis. He was born in South Australia in 1888, and educated at the University of Adelaide; later he did graduate work under Sir William Bragg at the University of Leeds. He held instructorships in physics at Toronto, Lehigh, Missouri, and Iowa State College. In 1920 he joined the department of physics at Washington University and became professor of physics in 1930, a position which he held at the time of his death.

During the twenty years following his appointment, Jauncey carried out research on many phases of X-ray scattering, the results of which are to be found in numerous communications in the *Physical Review* and other journals. He was also deeply interested in students and the problems of teaching physics at all levels. Out of his interest in teaching undergraduates at an intermediate level resulted his widely used book "Modern Physics", which has passed through three editions.

A severe illness in 1940 resulted in a permanent impairment in his health, which made it impossible for him to continue experimental work. He then turned his attention to the history of physics. The papers which he had published were to have been followed by others in this field had he lived to work out his programme.

A. L. HUGHES

Prof. G. Matthai

WE regret to announce the death at Cambridge on June 25 of Prof. George Matthai, formerly of the Indian Educational Service and emeritus professor of zoology in the University of the Punjab at Lahore. Dr. Matthai succeeded the late Lieut.-Colonel J. Stephenson as professor of zoology at Lahore in 1919. Under Stephenson the Lahore School of Zoology had been raised to a high degree of efficiency and was *facile princeps* among the Indian Schools; Prof. Matthai worked hard to maintain this proud position, though of late years Lahore has been challenged and has had to yield pride of place to Lucknow. Prof. Matthai would under normal conditions have retired in 1942, but as a war measure his term of office was extended until 1945.

Prof. Matthai was a recognized authority on corals, and as Mackinnon Student he had worked on the coral reefs of the West Indies: he also studied the corals and reefs of the Indian and Ceylon regions. He revised the classification of the Astræidæ and published several valuable monographs, the most important of which was the British Museum Catalogue of this family (1928). Negotiations were in progress to enable him to undertake the preparation of a similar monograph on the Fungiid Corals. His death is a great loss to systematic and taxonomic zoology.

R. B. SEYMOUR SEWELL

WE regret to announce the following deaths:

Prof. Noah Morris, regius professor of materia medica and therapeutics in the University of Glasgow since 1937.

Dr. Wilfred H. Osgood, emeritus curator of zoology in the Field Museum of Natural History, and a corresponding member of the Zoological Society of London, aged seventy-one.

Dr. John Parkinson, well known for his work in economic geology in many parts of the British Empire and elsewhere, on July 19, aged seventy-five.

NEWS and VIEWS

Prof. E. P. Cathcart, C.B.E., F.R.S.

Prof. E. P. Cathcart retires from the regius chair of physiology, University of Glasgow, this summer after having completed almost twenty years service in the senior chair of the Institute of Physiology. The previous nineteen years he spent as Gardiner professor of physiological chemistry in the same Institute. Cathcart matriculated as a student in 1895 and graduated M.B., Ch.B. in 1900. Four years later he took his M.D., and in 1906 received the degree of D.Sc. Periods of foreign study were passed in Munich, Berlin and Petrograd (with Pavlov), and with F. C. Benedict at the Carnegie Institution at Boston. It was in 1905 that Cathcart was appointed Grieve lecturer in physiological chemistry in his *alma mater*: then from 1915 until 1919 he was professor of physiology in the London Hospital Medical School. During the First World War he occupied an important post in our anti-gas measures and held the rank of lieutenant-colonel. Afterwards he became a member of the Army Advisory Committee on Nutrition and on Hygiene. He was also a member of the Technical Committee on Nutrition of the League of Nations, and served on the Medical and Agricultural Research Councils. He was for many years a member of the General Medical Council. Among the other posts which he has held, his chairmanship of the Industrial Health Research Board and of the Scottish Health Services Committee are probably the most outstanding.

Cathcart's main lines of inquiry have been directed to the study of the physiology and efficiency of muscle work, and to the physiology of starvation and protein metabolism. His inquiries into the national diet and those of its constituent classes were models of their kind, and his advice was much sought after by Government departments. His most important publication was probably his monograph on "The Physiology of Protein Metabolism". Many have regretted that he did not publish editions other than the first. Cathcart belongs to the now very small group of men who have a wide interest in physiology in all its branches. He has a rare gift of inspiring and encouraging the best efforts of his junior colleagues. To the outsider he has always presented a rather gruff exterior, and he did not tolerate fools gladly; once admitted to his friendship, he was the staunchest of friends. In 1913 Prof. Cathcart married Miss Gertrude Norman Bostock, herself a doctor and one who has contributed to the physiology of metabolism in papers to the *Biochemical Journal*. She has been a most devoted and active wife, and her contribution to the welfare work of the University of Glasgow Settlement has been outstanding.

Prof. R. C. Garry

Prof. Robert Campbell Garry has been appointed to succeed Prof. Cathcart in the regius chair of physiology at Glasgow. Prof. Garry, who was the most distinguished graduate of his year (1922) in the University of Glasgow, obtaining his M.B., Ch.B. degree with first class honours, has held the chair of physiology at University College, Dundee, since 1935. After a period of training both in research and teaching in the Physiology Laboratory of the University of Glasgow and at Freiburg under the late Prof. Paul Trendelenburg and with Prof. Lovatt Evans at University College, London, he was appointed in 1933 head of the Physiology Department of the Rowett Institute in Aberdeen. This post he held until his promotion to Dundee. Prof. Garry has had considerable experience in administration work, as he has served for two terms of three years as assessor on the University Court of the University of St. Andrews and as an elected representative on the Council of University College, Dundee. He has always, since his earliest days in the Physiology Department of the University of Glasgow, been interested in the popularization of science, and was one of the pioneer lecturers in physiology to classes organised by the Workers Educational Association. This work, as well as his series of school broadcasts, was most successful. Prof. Garry has always been a keen research worker; in his early days his activities were directed to applied physiology, and latterly they have in the main been turned to general experimental work, particularly to the relation of the caudal region of the large bowel, and more recently to problems of nutrition. He is an editor of the newly founded *British Journal of Nutrition*. Prof. Garry was elected in 1943 a member of the editorial board (and is now chairman of the board) of the *Journal of Physiology*. He was elected a fellow of the Royal Society of Edinburgh in 1936 and was a member of its Council during 1938–41.

East African Institute of Social Research: Lieut.-Colonel W. E. H. Stanner

The Secretary of State for the Colonies has appointed Lieut.-Colonel W. E. H. Stanner to be director of an East African Institute of Social Research, the establishment of which is to be financed from a grant of £66,915 made in November 1945, under the Colonial Development and Welfare Act. The Institute will be associated with Makerere College, Uganda, which is being developed into the University College of East Africa. Colonel Stanner, an Australian, who is forty-one years old, is a graduate of the University of Sydney and a Ph.D. of the University of London (London School of Economics). He has carried out extensive field research in social anthropology in northern Australia and in Kenya. Recently, he has been engaged on research in the South Pacific on behalf of the Institute of Pacific Relations.

Redwood Medal of the Institute of Petroleum

The Redwood Medal of the Institute of Petroleum has been awarded to H. S. Gibson, general fields manager, Anglo-Iranian Oil Co., Ltd., Abadan, for his unique work on the production of petroleum. Established in 1921 in honour of Sir Boverton Redwood, founder-president of the Institute, the Redwood Medal is awarded "to a petroleum technologist of outstanding eminence, irrespective of nationality or membership of the Institute". Only seven previous awards have been made since the medal was instituted, the last being in 1938. Mr. H. S. Gibson served in the First World War in France, Egypt, Salonica and Turkey, and was mentioned in dispatches. On demobilization in 1919 he went to Emmanuel College, Cambridge, where he took the Mechanical Science Tripos. In 1922 he joined the (then) Anglo-Persian Oil Co., Ltd., as production engineer, and advanced steadily until in 1945 he was made general fields manager. He was awarded the C.B.E. in this year's King's Birthday honours.

Detection by Radar of a New Meteor Shower

British Astronomical Association Circular No. 282 gives a short note from Dr. A. C. B. Lovell, director of radar research on meteors at the University of Manchester, who has announced the discovery of a new shower during daylight. For some time radio reflexion has been used to study the ionization caused by meteors in the upper atmosphere (see *Nature*, July 19, pp. 74 and 76). Certain radiants have been selected and studied carefully by means of a beam of radiation about ± 6° wide which can be directed to any point in the heavens, and Mr. J. A. Clegg has devised a method by which it is possible to determine very accurately the radiant of a stream. No details about this method have been published up to the present, but it may be assumed that it is capable of providing more accurate results than those obtained from visual observations. It is interesting to know that the investigation of the radiants of the well-known showers during the autumn and winter shows, apart from minor variations, that the radiants determined by Mr. J. P. M. Prentice, director of the Meteor Section, British Astronomical Association, and his colleagues, agree closely with those found by Mr. Clegg's method.

The investigation of the η Aquarid stream was commenced on May 1, and it was obvious that this well-known stream was merely the beginning of a very active belt stretching towards the sun, the main radiant point of this stream lying in the constellation of Pisces. As this latter radiant crossed the meridian at about 10h.–11h., depending on the period of observation in May, no knowledge of this shower was possible from visual observation. The Aquarius end of this belt disappeared in mid-May; but the Piscid radiant continued with great intensity, and on June 22 the shower, which had continued for 35 days, was still active, the radiant being now in Taurus, and showed no signs of ending. While fluctuations in intensity have occurred, the hourly rate at transit has often exceeded 80 and has never fallen below 20. Preliminary analysis has given the following approximate positions of the new radiant:

May 7	R.A.	1h.	20m.	N. Dec.	20°–25°
June 22		4	40		20 –25

Minor radiants have also appeared for a few days about 15° W. and 10° E. of the main knot, but at the same declination, and on some occasions the whole area between these extremes has been active.

Institutum Divi Thomæ: Extension of Facilities

The Donner Foundation, Inc., the head of which is William H. Donner, of Philadelphia, has given a 64-room building in Palm Beach, Fla., to the Institutum Divi Thomæ, of Cincinnati, Ohio, for scientific research. The building, to be known as Donner Hall, was formerly a part of the estate of the late Colonel E. R. Bradley, and is adjacent to Bradley Hall, now occupied by the marine biological laboratories of the Institutum Divi Thomæ. Dr. George S. Sperti, director of the Institutum, states that Donner Hall will provide quarters for what is planned eventually to be the largest marine biophysics laboratory in the world; the Institutum already maintains a floating laboratory, the *Aquina*, which will become part of this programme. Secondly, since cancer in its simplest terms is a problem in cell division, and since lower forms of sea life offer convenient material for studying cell reproduction, Donner Hall will provide for intensive fundamental research in cancer. Finally, it will provide quarters for visiting scientific workers from various parts of the world, who will be invited to participate in a series of symposia devoted to different fields of research. The Institutum Divi Thomæ, founded in 1935 by the Most Rev. John T. McNicholas, Archbishop of Cincinnati, as a graduate research school, open to all scientific workers regardless of race, colour or creed, now has fourteen affiliated units throughout the United States; it has already been responsible for important work in various fields, notably biochemistry and biophysics. William H. Donner, whose generosity has opened the way to the establishment of the new cancer research centre, has previously given large sums for the study of cancer. He was born in Columbus, Ind., in 1864, and is a Presbyterian. Beginning as treasurer of the National Tin Plate Company at Anderson, Ind., Mr. Donner built its plate works near Pittsburgh and founded Monessen, Pa., before the company was absorbed by the American Tin Plate Company. He then built up another steel corporation in the same way until it became part of the Union Steel Company, which in turn was purchased by the United States Steel Corporation.

Television in the United States

The Radio Corporation of America has played a prominent pioneer part in the practical development of television in the United States, more particularly since 1923, when Dr. V. K. Zworykin applied for a patent on the now world-famous iconoscope. Much of this pioneer work has been inspired by Brigadier General Sarnoff, president of the Radio Corporation of America, and it is the purpose of an illustrated booklet recently issued by the Information Department of the Corporation (New York, 20) to present excerpts from General Sarnoff's statements on the subject at various public meetings and demonstrations during the past twenty-four years. Much of the results of the work conducted in the research laboratories of the R.C.A. is described in scientific and technical papers published in various journals, including the *R.C.A. Review*, to which reference was made in *Nature* of September 14, 1946 (p. 373). The publishers of this *Review* have now issued a bibliography of technical papers on television by R.C.A. authors. This includes some 275 technical papers on television and closely related subjects published during the period 1929–46, and arranged generally in chronological order. This "Television Bibliography" is in the same handy size (about 9 in. × 6 in.) as the *R.C.A. Review*, and should prove useful and convenient to all those concerned with the study, development and application of television. It is to be regretted that while the references give the year and month of publication, they do not give the volume and page number of the journal in question.

Mesozoic Faunas of Peru

In 1941, Dr. William F. Jenks sent rich collections of fossils, made in the course of his field work in the Cerro de Pasco region of central Peru, to Dr. Otto Haas, of the American Museum of Natural History, New York, for identification. Ever since, a steadily increasing amount of Peruvian fossil invertebrates has been accumulating at the Museum. Collections made during 1943–46 by Dr. Norman D. Newell in central, eastern and southern Peru, by Mr. Bernhard Kummel in northern, central and eastern Peru, and by Dr. Jenks in southern Peru have since been added to that initial material, and it is hoped that additional collections will be brought in by a forthcoming expedition to Peru under Dr. Newell's leadership. Besides Palæozoic assemblages, to be studied and published separately, most of those collections are of Mesozoic age. The work of description is being divided among several specialists. So far, Dr. Raymond E. Peck and Mr. Reker have just finished a report on charophytes from various regions and horizons, intended for publication in the American Museum *Novitates*, Dr. John W. Wells will study the Anthozoa and Porifera, Dr. Newell has taken charge of the pelecypods, and Dr. Kummel will concentrate on Triassic cephalopods. Dr. Haas is studying the Post-Triassic cephalopods and the gastropods. Some important groups, especially the brachiopods, which are second only to the molluscs in number of specimens, are still waiting for specialists to undertake their study. The Instituto Geológico del Perú, the director of which is Dr. Jorge Broggi, is co-operating with the American Museum of Natural History in all this work.

Royal Commission for the Exhibition of 1851 : Overseas Scholarships 1947

The Commissioners of the Royal Commission for the Exhibition of 1851 announce the award of Overseas Science Research Scholarships for 1947 to the following, the recommending body appearing in brackets: E. Gorham (Dalhousie University, Halifax), for research in plant ecology at University College, London; W. A. Bryce (McGill University, Montreal), for research in physical chemistry at the University of Oxford; C. C. Costain (University of Saskatchewan), for research in physics at the University of Cambridge; D. R. Bowes (University of Adelaide), for research in geology at the Imperial College of Science and Technology, London; L. Riddiford (University of Melbourne), for research in physics at the University of Birmingham, or the University of Manchester; Miss June Lascelles (University of Sydney), for research in biochemistry at the University of Oxford; J. N. Dodd (University of New Zealand), for research in physics at the University of Birmingham; J. P. Teegan (National University of Ireland), for research in physical chemistry at the University of Cambridge; Dr. A. K. Saha (University of Calcutta), for research in physics at the University of Birmingham; Dr. A. B. Bhatia (University of Allahabad), for research in physics at the University of Bristol.

Leverhulme Research Fellowships: Awards for 1947

The following awards, among others, for research in the subject mentioned and tenable for periods up to two years, have been announced by the trustees of the Leverhulme Research Fellowships: *Fellowships*: R. C. Abraham, late district officer, Nigeria, modern languages of Ethiopia and Eritrea (renewal); Dr. R. Dennell, reader in experimental zoology, University of Manchester, structure and physiology of the luminous organs of the Decapoda; J. A. Ratcliffe, lecturer in physics, University of Cambridge, propagation of radio waves; Dr. R. Stoneley, lecturer in mathematics, University of Cambridge, elastic yielding of the earth. *Research Grants*: Dr. P. Allen, demonstrator in geology, University of Cambridge, comparative petrology and palæoecology of the European 'Wealden'; J. S. Barlee, biology master, Royal Naval College, Dartmouth, investigation into the status of certain birds in Ireland; Miss E. M. Brown, lecturer in zoology, Chelsea Polytechnic, London, parasitic dinoflagellates and other causal organisms of disease in fish; Dr. J. G. D. Clark, lecturer in archæology, University of Cambridge, economic and social prehistory of Europe since late-Glacial times; J. S. Gittins, principal, Aycliffe Approved School, Darlington, a survey of the mental characteristics of delinquent boys; Dr. J. Grant, medical officer of health, County Borough of Gateshead, a study of epidemic diphtheria; Dr. F. R. Irvine, administrative officer, Faculty of Science, University of Edinburgh, indigenous plants of West Africa and their utilization for local purposes; P. Slater, principal research officer, Social Survey, use of statistical methods in forecasting human behaviour. Information in connexion with Leverhulme awards can be obtained from the Secretary, Leverhulme Research Fellowships, 7 Bedford Row, London, W.C.1.

The Night Sky in August

Full moon occurs on August 2d. 01h. 50m. U.T. and new moon on August 16d. 11h. 12m. The following conjunctions with the moon take place: August 12d. 22h., Mars 2° S.; August 15d. 10h., Mercury 4° S.; August 22d. 18h., Jupiter 0·1° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Jupiter on August 18d. 13h., Mercury being 0·6° N. Mercury rises 1h. 22m. before the sun on August 1, but will not be an easy object to observe. It attains its greatest western elongation on August 3, and at the end of the month is a morning star, rising only 10 minutes before the sun. Venus rises 50 minutes before the sun on August 1 and practically at sunrise on August 31, and will not be well placed for observation during the month. Mars, in Gemini, is visible in the early morning hours, rising soon after midnight during most of the month. Jupiter, in the constellation of Libra, is visible in the early portion of the night, setting at 23h. and 21h. 06m. at the beginning and end of the month, respectively. Saturn, in conjunction with the sun on August 5, cannot be seen. The following occultations of stars brighter than magnitude 6 take place: August 14d. 03h. 21·5m., *A* Gemi. (*R*); August 24d. 20h. 29·0m., 88 *B* Ophi. (*D*). *R* and *D* refer to reappearance and disappearance, respectively, and the latitude of Greenwich is assumed. The Perseid shower of meteors attains its maximum about August 10–12; the radiant is close to R.A. 3h., Dec. + 57°.

Announcements

The opening on July 14 of an Exhibition at the Science Museum, South Kensington, arranged with the Chemical Society, the eleventh International Congress of Pure and Applied Chemistry and the Department of Scientific and Industrial Research to illustrate the achievements of British chemists during the past century and to show the uses of chemistry in everyday life, marked the beginning of the centenary celebrations of the Chemical Society. The exhibition is now available to the general public, and will remain open until September 30 (weekdays, including August Bank Holiday, 10 a.m.–6 p.m.; Sundays, 2.30 p.m.–6 p.m.).

Dr. Adrien Albert, who for the last nine years has been working at the University of Sydney on the physics and chemistry of drug action, has joined the staff of the Wellcome Research Institution, London, to initiate similar studies there.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

An Example of 'Mimicry' in Fishes

Among the genera of Cichlid fishes peculiar to Lake Nyasa, *Corematodus*, comprising two species, is characterized by the dentition, which consists in each jaw of a broad file-like band of small pointed teeth. Otherwise these two species would be included in the large genus *Haplochromis*, of which more than a hundred, nearly all endemic, have been recorded from Nyasa. Among the *Haplochromis* and their related genera in Nyasa, many species have a colour pattern characteristic of the Lake and rarely met with elsewhere in Africa, namely, a dark oblique band from nape to caudal fin. *Corematodus tæniatus* Trewavas also has this pattern on a silver-grey ground; the largest specimen known is 19 cm. in total length. *C. shiranus* Blgr. has quite a different pattern, consisting of vertical, or nearly vertical, black bars extending from the back to near the ventral surface. This pattern is exactly similar to that of females and non-breeding males of the Nyasa species of *Tilapia* of the *T. squamipinnis* group; and *C. shiranus* reaches a length of 27 cm., which is one of the commonest lengths of the *T. squamipinnis* caught during the Fishery Survey of 1939[1].

The guts of six specimens of each species of *Corematodus* were examined. The intestine is long, narrow and coiled. In each case stomach and intestine contained nothing but hundreds of minute scales exactly like those which cover the caudal fin of so many Cichlid species of Lake Nyasa, including *Tilapia squamipinnis*. The efficacy of the double file of the jaws of a *Corematodus* in rasping scales from the caudal fin of a *Tilapia* can easily be demonstrated, and except for the loss of some scales, the tail can be pulled undamaged from between the closed jaws. It seems that *Corematodus* specializes in this curious diet.

The strong superficial resemblance of *C. shiranus* to *T. squamipinnis* must be very useful to the former, enabling it to swim unnoticed in the shoals of *Tilapia*. The relationship between the two fulfils the conditions required of model and mimic. *Tilapia* is abundant and swims in shoals, *Corematodus* is relatively rare and is solitary, and reaps the advantage of the resemblance.

It was not found possible to identify the scales in the gut of either species of *Corematodus* as being those of *Tilapia* or of one of the *Haplochromis* group. It would be interesting to know if the two species do, in fact, select as victims fishes resembling them respectively in colour-pattern. The *Corematodus* seen were caught singly, in hauls including numerous *Tilapia* and also some oblique-banded Cichlids.

The two species of *Corematodus* were exhibited some years ago with the species they resemble by Dr. Tate Regan, but until 1939 their habits, which give point to the mimicry, were unknown.

Ethelwynn Trewavas

British Museum (Natural History),
London, S.W.7.
May 13.

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[1] Ricardo Bertram, C. K., Borley, H. J. H., and Trewavas, E., Report on the Fish and Fisheries of Lake Nyasa (1942); see p. 28 and p. 60.

A Fungus Parasitic on *Coptotermes curvignathus*, Holmgr.

During the course of some observations designed to determine the most suitable conditions for maintaining the workers of *Coptotermes curvignathus* (the termite pest of *Hevea brasiliensis*) in captivity, the development of an unusually high death-rate in one of the treatments led to an examination which disclosed that the insects had been parasitized by an entomophthoraceous fungus. The causal organism was isolated, and cultivated without difficulty on standard media and on rice-bran.

Its ability to parasitize and kill *Coptotermes* workers has been established experimentally; a 100 per cent kill being obtained within 48 hours in trials in which the insects (maintained in Petri dishes on sterile soil) were supplied with infected rice-bran as a source of food, the presence of the characteristic hyphæ in the tissues of the insects confirming the cause of death. The mortality in the controls, fed on sterile bran, was 3 per cent during the same period.

Reference to the literature suggests a relationship between this parasite and the species of *Conidiobolus* isolated from *Nasutitermes* by Kevorkian in Cuba[1]. The Imperial Mycological Institute, to which a culture was sent, considers, however, that the Malayan fungus does not completely agree with the Cuban fungus as that was described; in particular, the primary conidia of the first measure distinctly larger, and it has not been observed to form the structure termed 'villose resting spores'. Pending comparison with authentic material, it is regarded tentatively as a new species of *Conidiobolus*.

R. A. Altson

Rubber Research Institute of Malaya,
Kuala Lumpur, Malaya.
March 28.

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[1] Kevorkian, A. G., *J. Agric. Univ. Puerto Rico*, 21, 191 (1937).

A Disease of Pyrethrum in Kenya

The demand for pyrethrum (*Chrysanthemum cinerariifolium*) resulted in a greatly increased production of this profitable crop in Kenya during the War. It has been cultivated commercially in Kenya since 1928. From 1,864 tons in 1938, the yield rose to 7,409 tons from 52,837 acres in 1945. This acreage is concentrated in a few areas in the Highlands, most of it at an altitude between 6,000 ft. and 9,000 ft. Minor losses, due to root and crown rot, are of common occurrence, but until 1946 the crop had escaped any serious disease in spite of the continuous and intensive cultivation to which it has been subjected.

The most important of the higher yielding areas is on the Mau Escarpment, where in June 1946 a serious falling off in yield, estimated in some instances to be as high as 80 per cent, occurred. Although the plants themselves appeared healthy, the flower buds failed to develop on account of an attack by the fungus *Ramularia bellunensis* Speg.[1]. By the end of the year, the disease had spread to all the main pyrethrum areas with the exception of the Nyeri–Nanyuki area on the slopes of Mount Kenya, which, up to the time of writing, had remained free.

Although typically a disease of buds and flowers (see illustration), rarely extending beyond the apical inch or so of flower stalk, the disease has been found infrequently on the foliage. Here no definite spots are formed, but the infection starts from the tip of the leaf segments and extends inwards.

Ramularia bellunensis Speg. on *Chrysanthemum cinerariifolium*. × 2 approx.

R. bellunensis has been recorded as causing a disease of *Chrysanthemum frutescens* in Italy in 1929[2] and in England in 1938[3]. In Italy, leaves and unopened inflorescences of pot plants in a greenhouse were severely affected. In England, the foliage in all stages was attacked, the lesions extending inwards from leaf tip and margin. The fungus does not appear to have been recorded on *C. cinerariifolium*, although both the fungus and this host are believed to be endemic in the Mediterranean region.

The immersed stromatic bodies from which the conidiophores arise are abundantly developed on the inner surfaces of the involucral scales, fragments of which are readily distributed with the seed.

This is, perhaps, another example of an exotic fungus finding a ready victim and a more congenial environment than hitherto recorded. Its advent is regarded by the pyrethrum industry of Kenya with apprehension.

R. M. NATTRASS

Department of Agriculture,
Nairobi, Kenya Colony.
April 21.

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[1] Det. Imperial Mycological Institute.

[2] Voglino, P., L'avvizimento fogliare della Margherita bianca.—La Difesa delle Piante, VI, 3, 1 (1929) (extract R.A.M. VIII, 723).

[3] Oyler, Enid, Plant Diseases, Rep. Exp. Res. Sta. Cheshunt (1937) (extract R.A.M. XVII, 583).

Meiosis in Bougainvillea

A QUERY concerning the possibilities of crossing various horticultural varieties of Bougainvillea led me to examine meiosis in several of the more important ones available in Jamaica. Six varieties, Snow White, Formosa, Dark Purple, Ruby, Orange King and Royal Purple, were used. The first three have been assigned to the species *Bougainvillea glabra*, the next two to *B. spectabilis*, and the last is reputed to be a cross between unknown *glabra* and *spectabilis* types. In all six varieties, the chromosome number was found to be $2n = 34$. None of the available chromosome number lists gives any number for *B. spectabilis*, but Darlington and Ammal[1] list *B. glabra* as $2n = 20$. Since a counting error of 14 chromosomes is unlikely, it seems probable that the horticultural glabrous types are not directly derived from the true *B. glabra* but are species hybrids resulting from doubling in an $(x = 10) \times (x = 7)$ type. There is, however, little direct evidence for this assumption.

Cytologically, four of the varieties studied behave as regular diploids with 17^{II} at first metaphase and subsequent normal segregation (see table). All four are also fertile but apparently not completely so, as the seed set under natural conditions is not high. The remaining two types, Ruby and Orange King (the latter of which is reputedly a bud sport of the former), are meiotically irregular with most first metaphase plates showing from four to six univalents. These univalents follow the bivalents to the plate and then split. Of the resulting chromatids, about a third fail to be included in the daughter nuclei, but ultimately give rise to micro-nuclei in the tetrads. Chromatids included in the first telophase nuclei split again at second anaphase, but complete separation often fails and thus gives rise to second anaphase chromatin bridges. Both Ruby and Orange King appear to be completely sterile.

It is therefore tentatively assumed that the horticultural varieties of Bougainvillea are amphidiploids, and that a species (*B. spectabilis* ?) with a basic number of $x = 7$ should exist. In view of the horticultural importance of this genus, further investigation is indicated.

G. B. WILSON
(Botanist)

Department of Agriculture,
Jamaica, B.W.I.

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[1] Darlington, C. D., and Ammal, E. K. Janaki (Allen and Unwin, London, 1945).

MEIOSIS IN BOUGAINVILLEA

Species	Variety	X	$2n$	Fertility	Meiosis type	Remarks
B. glabra	Formosa	17	34	Fertile	Regular 17^{II} with normal segregation at divs. I and II	
	Snow White	17	34	,,	,, ,, ,,	
	Dark Purple	17	34	,,	,, ,, ,,	
B. spectabilis	Ruby	17	34	Sterile	Irregular with 4–6^{I} at M^{I}	Univalents split at first anaphase About $\frac{1}{3}$ excluded from nuclei
	Orange King	17	34	,,	,, ,, ,,	,, ,, ,, ,,
	Royal Purple	17	34	Fertile	Regular with 17^{II} at M^{I}	

A Rapid Nigrosine Method for Chromosome Counts Applicable to Growing Plant Tissues

FOR a plant-breeder dealing with plants which can be cross-fertilized who desires to work up polyploid material on a large scale, annual control of the purity of the polyploid stocks as regards chromosome number is necessary. A breeder of fruit and forest trees should also have at his command methods by which the chromosome numbers in new artificial or spontaneous crosses can be simply separated.

A grading of the polyploid chromosome number groups only requires an estimation of the number of chromosomes in the genome (for example, in *Beta*, 36 ± 2–4). Further, chromosome counting should be possible at any time in the whole vital cycle of the plants (including pollen mother-cells) and by the same simple method. In the method described below the treatment is essentially the same for roots as for leaves and flower-buds. Any deviations between them are noted in their proper connexion.

Fixing. Fix in 1 part of concentrated (98 per cent) acetic acid + 2 parts of 95 per cent alcohol for about 24 hours. Roots should be fixed in a cooled fluid.

Loosening of the tissues. Replace the fixing fluid with a cooled mixture of 1 part of concentrated hydrochloric acid (sp.gr. 1·27) + 2 parts of 95 per cent alcohol. Roots are treated for 8–10 min. For leaves the character of the tissues will decide the concentration and time: *Beta*, 1 : 2 for 7–8 min.; *Pisum*, 1 : 4 for 5 min.; *Pyrus* and *Betula*, 1 : 1 for 10 min.; flower-buds, 1 : 10 for 5–8 min.

Washing. Replace the loosening fluid with distilled water and preserve in a cool place for 15–30 min. (thick leaf tissues and body complexes for 60 min.).

Staining. Place four or five roots on an object glass. Cut away portions not showing divisions; suck off. For a leaf specimen, take a *small* piece from the base of a leaf on a quickly growing part of the stem. Squeeze flower-buds into pieces so that large portions of the bracts are picked off with a pincette. One drop of staining solution is added. With an ordinary piece of stiff eraser rubber (*a*) tap gently on the cover glass, (*b*) press fairly gently over the whole cover glass, (*c*) press hard with short vibratory movements, (*d*) lift the cover glass until the staining solution flows in over the tissues. Considerably less pressure is used for leaves. Pollen mother-cells are pressed still more gently. For roots the staining time is 1–2 min. The staining fluid should be cool. Leaves of *Pisum* are stained for 30 sec., *Beta* 40 sec., those of *Pyrus* and *Betula* for 45–60 sec. For these types of tissues, 4 per cent staining fluid is used; for buds, 3 per cent solution. The pigment colours the chromosomes quite black and the plasm a faint grey.

After staining, pass a rubber roller to and fro some ten times over the cover glass, on which a filter-paper is laid.

Staining fluid. Prepare a 4 per cent solution as follows: dilute 50 c.c. of concentrated (98 per cent) acetic acid with distilled water to 100 c.c. Heat to boiling-point. Add, continuously stirring the while, 4 gm. of spirit-soluble nigrosine[1]. Boil for 3–5 min. to a weak tarry consistency. Cool and filter immediately. Keep the solution in a closed glass vessel at room temperature for about 10–14 days before use.

Two girls previously quite unacquainted with cytological and similar technique are using this method at Hilleshög. To-day their capacity is 100–120 plant-counts on root-tips per working day of seven hours. Leaf-counts can be made even more quickly than root-counts (150–200 plants per day).

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April 18.

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[1] *Stain Tech.*, 10, 73 (1935).

Feeding Mechanism of Water-bugs

AN account has been given by H. D. Slack of the cibarial suction pump of Corixidæ, in which a modification producing the effect of chitinous jaws was noted[1]. A full account of the head and mouth parts of *Rhamphocorixa acuminata* has been previously given by M. E. Griffith[2]. Further, H. B. Hungerford[3] has found solid food in the alimentary canal of Corixidæ, in particular, jaws of rotifers, filaments of *Oscillatoria* sp. and *Mougeotia* sp., slime diatoms, etc. In an investigation begun in 1943, I have confirmed much of this work, and, in addition, have found legs of Crustacea, *Anabæna* sp., undamaged filaments of *Spirogyra* sp., an unexploded nematocyst, pollen grains, etc. I have also made observations on the feeding of *Sigara striata*, *S. falleni*, *Corixa punctata* and *C. panzeri*, on chironomid larvæ, Mayfly nymphs and daphnids. In all cases the live food was pierced and anchored by the mouth parts, probably by the mandibular teeth described by M. E. Griffith[2]. The food thus seized was held for periods varying from five to twenty minutes, during which time some of the contents of the living animal were sucked into the corixid. On one occasion black pigment from the eye of a daphnid was observed streaming through the pharynx.

H. D. Slack suggests that the cibarial 'teeth' probably have the function of comminuting the solid food ingested, a function also attributed to the masticator described by Griffith. This may be so; but in many instances the contents of the mid-gut are found to be remarkably intact, while the finely comminuted food there is usually identical with the detritus upon which corixids frequently feed.

That there is a difference in chitinization between early instar nymphs and adults is in agreement with observations made by me on the instars of *C. panzeri*[4]. The general chitinization of the first and second instars is much less intense than in later instars and adults. An investigation of the gut contents of early instars indicates little difference in food ingested compared with that of later instars and the adult. Possibly, therefore, the heavier chitinization of the cibarial teeth in the adult is not due to a change in diet, but is part of a general increase in body chitin. An investigation of the histology of the alimentary canal and nutrition of Corixidæ was begun in 1943, and the results are shortly to be published.

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May 9.

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[1] *Nature*, 159, 605 (1947).

[2] Griffith, M. E., *Univ. Kansas. Sci. Bull.*, 30, Part II, No. 14 (June 1945).

[3] Hungerford, H. B., *Univ. Kansas Sci. Bull.*, 11, 1 (1933).

[4] Sutton, M. F., *Proc. Linn. Soc.*, 158. Pt. 1, 51 (1947).

Individual Activity of Ants

FOLLOWING the publication of my note on the "Division of Labour in Ants"[1], Dr. T. Cunliffe Barnes of Philadelphia has directed my attention to his paper on "The Rhythms of Activity in Ant Colonies"[2], of which I was previously unaware.

In the course of his experiments, Dr. Barnes observed "that certain restless individuals in the group [of ants] were constantly arousing inactive individuals to activity by touching them with the antennæ". Brief details of the occurrence of this phenomenon in two experiments are given. These restless 'catalyst' ants of Dr. Barnes are the equivalent of the 'excitement centres' in my theory of the division of labour. Although Dr. Barnes did not study the behaviour of his ants in relation to the division of labour, but was only concerned with the activity or inactivity of individuals and groups, it is of considerable interest that when the ants were placed in artificial nests where they had no occupation (or queens ?) certain individual ants showed greater physical activity than others, and were capable of stimulating the whole group of ants into similar activity. Thus even when the ants are not employed in any occupation, they may still be stimulated into undirected physical activity by individuals acting as 'excitement centres'. It would be interesting to know how far this individual liveliness is correlated with hard-workingness and laziness when ants are engaged in definite tasks (see Chen[3]) and with the ability to learn (see Schneirla[4]).

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20 Robert Adam Street,
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April 10.

[1] Wragge Morley, D., *Nature*, 158, 913 (1946).
[2] Cunliffe Barnes, T., *J. Gen. Psychol.*, 25, 249 (1941).
[3] Chen, S. C., *Physiol Zool.*, 10, 420 and 437 (1938).
[4] Schneirla, T. C., *J. Comp. Psychol.*, 15, 243 (1933); 17, 303 (1934); 32, 41 (1941); 35, 149 (1943); *J. New York Ent. Soc.*, 52, 153 (1944), and other papers.

A New Locality for *Cyprinodon dispar* Rueppel

IN the winter of 1943–44, large shoals of *Cyprinodon dispar* Rueppel appeared in shallow water near the shore off Tel-Aviv. In the summer of 1944 they were found to be abundant in the salt pans of Athlith, south of Haifa. *Cyprinodon dispar* has not hitherto been reported from the Mediterranean Sea.

The marine specimens differ distinctly in body-shape and colour from specimens from the brackish springs in the neighbourhood of the Dead Sea. A detailed description will be published elsewhere. Specimens of both populations were kept in aquaria under like conditions and bred true to type.

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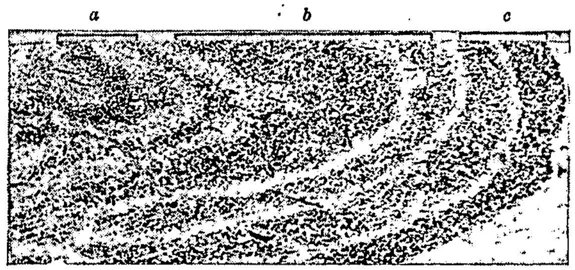
April 21.

A Possible Central Mechanism for Colour Vision

SOME years ago, one of us submitted evidence to show that the conducting unit from the central area of the retina in man and the higher primates is a three-fibre unit[1]. It was further suggested that this anatomical fact might be related to the trichromatic theory of colour vision. Recently we have been making a detailed analysis of the main visual centre, the lateral geniculate nucleus, of the human brain, with special reference to its laminar pattern, the relative extent of the several cell layers, and their distribution over the projection areas corresponding to different parts of the retina.

In the central retinal area of the nucleus there are three cell layers related to each eye. These layers may be called *a*, *b* and *c* (the *a* layer, which is the most superficial, being composed of much fewer and larger cells). The component fibres of the three-fibre unit ending in these layers may also be called *a*, *b* and *c* fibres. It is now possible to make the following statements with reference to the human retina and geniculate nucleus. From the central area of the retina the conducting unit is a three-fibre unit consisting of *a*, *b* and *c* fibres. At the fixation point the unit consists of *b* and *c* fibres; *a* fibres are relatively very few (or may be absent altogether). From the peripheral retina there is also a functional unit of two fibres, here represented by *a* and $(b + c)$—that is to say, one fibre of the unit terminates in layer *a* and the other in a region of the geniculate nucleus formed by a fusion of layers *b* and *c*. If we assume (as we believe our evidence permits us to do) that there are not great variations in the fibre-cell ratio in the geniculate nucleus, we can also say that, taking the retina as a whole, the *a* fibres are much fewer than the *b* or the *c* fibres; on the other hand, the relative number of *a* fibres increases progressively towards the periphery of the retina. Lastly, from the central area of the retina, *c* fibres preponderate over *b* fibres.

We are well aware of the complexities of colour vision problems, and we ourselves do not feel competent to discuss them. Nevertheless, for the consideration of those who are better qualified in that respect, we would like to put forward the following points. If it be supposed that the *a* fibres correspond to the blue factor of trichromasy, this would explain their proportionate increase towards the periphery of the retina, which fits in with the observation that, in the distribution of colour sensitivity over the field of vision in moderate illumination, blue has the widest extent peripherally. The fact that, over the retina as a whole, the *a* fibres are much fewer than the *b* or *c* fibres corresponds with the fact that, as shown in photopic visibility curves, luminosity is least in the blue part of the spectrum and reaches its maximum in the yellow part (that is, the part representing, according to the trichromatic theory, a fusion of the red and green factors). The paucity (or possible absence) of the *a* fibres from the foveal centre accords well with the evidence that here the retina is relatively insensitive to blue. Lastly, it has been found[2] that if monkeys are kept for some weeks in light from which the blue end of the spectrum is completely excluded, the cells in the central retinal zone of cell layer *a* may undergo marked atrophic changes.



SECTION OF THE LATERAL GENICULATE BODY OF A MONKEY SHOWING SELECTIVE CELL ATROPHY IN THE CELL LAYER *a* WHICH RECEIVES CROSSED RETINAL FIBRES (THAT IS, THE FIRST LAYER ON THE LEFT IN THE PHOTOGRAPH). × 20

In the accompanying microphotograph this selective atrophy is well shown; for reasons which are not apparent, it is mainly limited to the layer which receives crossed retinal fibres only. It should be noted, also, that some degree of cell atrophy may affect the central zones of layers *b* and *c*, but this is less conspicuous than in layer *a*. If the *b* and *c* fibres are related to the red and green factors of trichromasy, then the fact that the functional conducting unit for the peripheral retina consists of *a* and $(b + c)$ fibres explains the observation that in the field of vision the area of sensitivity for yellow extends farther than that for green or red separately; for the impulses from the receptors related to the *b* and *c* fibres would be conveyed to a common mass of geniculate cells (formed by the fusion in that area of layers *b* and *c*) and would thus not be kept segregated in the visual paths beyond the geniculate level.

We would suggest that these correlations (together with those reported in a previous paper[1]) offer further presumptive evidence that the six-layered pattern of the geniculate nucleus (that is, two sets of three layers for the two eyes) may be related to colour vision. However, further and more detailed correlations need to be established, and much more experimental evidence is required in order to put our thesis to a crucial test.

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L. Chacko

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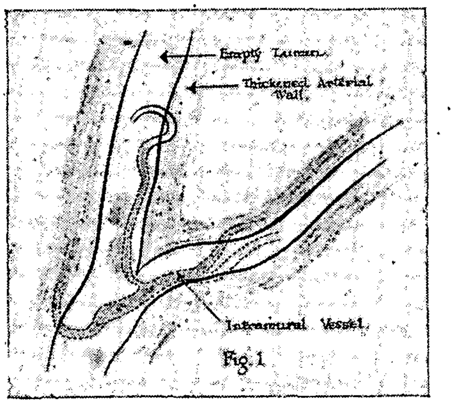
May 27.

[1] Le Gros Clark, W. E., *J. Anat.*, 75, 225 (1941).

[2] Le Gros Clark, W. E., *Trans. Ophth. Soc.*, 62, 229 (1942).

Intramural Vessels in the Retina (Vasa vasorum)

Investigating ocular tissue of man and of some animals by a clearing method during the last seven years, I have found intramural vessels in retinal arteries and veins. They were discovered in bulk specimens, their existence proved later on by reconstruction of serial sections. Intramural vessels in the retina run within the wall parallel to the lumen or encircling it or in spirals around it. They often branch and the twigs frequently reunite. I have not found them so far in the retinal vessels of young healthy human beings. Intramural vessels have been described in atheromatous diseased coronary arteries of the heart[1]. The purpose of these newly built retinal vessels in some cases may be to bypass an obstacle in the bloodstream. In other cases with intramural vessels, however, the retinal arteries show hyaline sclerosis with preservation of the lumen. It is possible that in the latter case the intramural vessels act as vasa vasorum and improve the insufficient nourishment of the changed vessel wall. They are considered as an attempt at healing of the sclerotic process. A detailed account of these findings will be published elsewhere.



INTRAMURAL VESSEL IN A SCLEROTIC RETINAL ARTERY, SEEN IN BULK, CLEARED WITH GLYCERIN. UNSTAINED. × 75

Arnold Loewenstein

Tennent Institute,
University, Glasgow.
May 12.

[1] Winternitz, Thomas, and Le Compte, "Biology of Arteriosclerosis" (Ch. C. Thomas, Springfield, Ill., 1938).

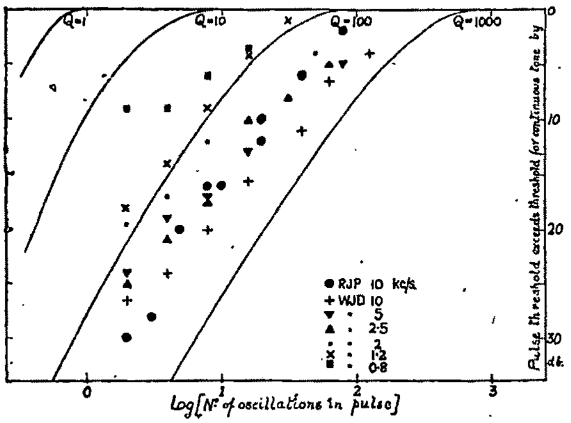
Transient Reception and the Degree of Resonance of the Human Ear

It is now more than eighty years since Helmholtz[1] gave a functional explanation of the architecture of the cochlea, and at the same time supplied a plausible physical basis for the extraordinary pitch discrimination of which the human ear is capable. Recent authorities have, implicitly or explicitly rejected Helmholtz's explanation of pitch discrimination. For example, Stevens and Davis[2] say "Everything considered, then, we must conclude that the inner ear is highly damped and that this damping impairs its resolving power in the analysis of sound waves" (p. 287); and elsewhere it is implied that the damping is critical. We cannot here consider the evidence adduced by Stevens and Davis and by others in favour of high damping of the cochlea, and must limit ourselves to the blunt statement that it is inadequate. It is the purpose of this letter to put forward evidence, independent of pitch discrimination, which unequivocally supports Helmholtz's original belief.

We shall use the familiar parameter Q to describe the behaviour of resonators. For all simple resonators there is a resonant frequency, f_0, and a value of Q which is finite and positive. If such a resonator is in forced oscillation, and the frequency of the impressed force is altered from f_0 to $f_0 \pm (f_0/2Q)$, the oscillatory energy stored in the resonator is halved. Q is a measure of the selectivity of the resonator, and when Q is small the resonator is said to be heavily damped. In particular, when $Q = 0{\cdot}5$, it is said to be critically damped. For $Q > 25$ the resonator is said to be lightly damped, and when the impressed force is removed the resonator will continue to oscillate at a frequency which differs from f_0 by less than 1 per cent, and with an amplitude diminishing by $1/e$ every Q/π cycles.

Now let it be assumed that the fibres of the basilar membrane are lightly damped and independent resonant elements arranged, as Helmholtz supposed, like piano wires in ascending order of frequency from the apical to the basal end of the membrane. Further, let it be assumed that for each fibre a particular finite amplitude of oscillation is necessary to produce an audible sensation. Then, if the threshold sound intensity for a continuous pure tone is known and if a value for the Q of the fibre resonant to that tone is assumed, the threshold of audibility for a pulse consisting of any integral number of half-periods can be predicted. Conversely, if the threshold for such pulses can be measured experimentally, the Q can be determined.

We have performed this experiment for a number of frequencies between 1 and 10 kilocycles per second, and for pulse-lengths ranging from 2 oscillations to 250 oscillations. In the accompanying figure the smooth lines are calculated for a number of values of Q. The points are experimental determinations at the frequencies indicated. Considering the well-known difficulty of obtaining reproducible results from subjective auditory measurements, the scatter is small and the agreement with the predicted slope satisfactorily close. We are therefore justified in ascribing to the resonators of the cochlea a Q of about 200–350 from $2\frac{1}{2}$ to 10 kilocycles, falling to about 50 at 1,000 cycles. For technical reasons we have not been able to make measurements at frequencies much below 1,000 cycles, but it is extremely likely that the Q continues to fall with frequency. If it were the same at 100 c./s. as at 10,000 c./s.,



the resonator at the lower frequency would 'ring', when the stimulus ceased, one hundred times as long as the resonator at the higher, with a consequent blurring of the appreciation of changing intensity at low frequencies. The number of discriminable intervals of pitch per octave at the lower end of the spectrum is about one twentieth of the number at the upper end[3]. Moreover, Bürck, Kotowski and Lichte[4] found that three or four oscillations are sufficient to produce a recognizable sensation of pitch at 50 c./s., whereas 250 oscillations were required at 10 kc./s. Both these facts support the belief that the Q may be 10 or less, at the extreme apical end of the cochlea.

It remains to show that the values of Q we find are adequate to explain pitch discrimination. We know already that the least perceptible increment in the intensity of a 10 kc./s. pure tone is of the order of 2 decibels, corresponding to an amplitude change of approximately 30 per cent. We assume that the resonators are equal in number to the inner row of hair cells and their resonant frequencies are distributed correspondingly to the distribution of discriminable pitch intervals; that is, there are roughly 2½ resonators per discriminable pitch interval, and at 10 kc. a density of 470 resonators per octave. At this frequency, a frequency change of 50 c./s. can be detected. But, if the Q of the resonators is 200 and one of them responds with unit amplitude to a pure tone at its resonant frequency, the respective amplitudes of its nearest, nearest-but-one and nearest-but-two neighbours will be respectively less than unity by 25, 45 and 60 per cent, a difference more than adequate to account for the frequency discrimination actually found. A large part of the margin would, however, vanish if allowance were made for fortuitous irregularities in the series of resonators.

It is clear, therefore, that a quantitative explanation of pitch discrimination above 1,000 c./s. is possible if, and only if, our findings for the Q of the ear are of the right order. The assumption of high damping involves the complementary assumption of a far finer intensity discrimination than is either plausible or consistent with experimental data.

R. J. PUMPHREY
T. GOLD

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May 6.

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[1] Helmholtz, "Tonempfindung" (1862).

[2] Stevens and Davis, "Hearing" (1938); see also Gabor, *Nature*, 159, 591 (1947).

[3] Shower and Biddulph, *J. Acous. Soc. Amer.*, 4, 288 (1931).

[4] Bürck, Kotowski and Lichte, *Elek. Nachr. Tech.*, 12, 355 (1935).

Crystalline Bacterial Catalase

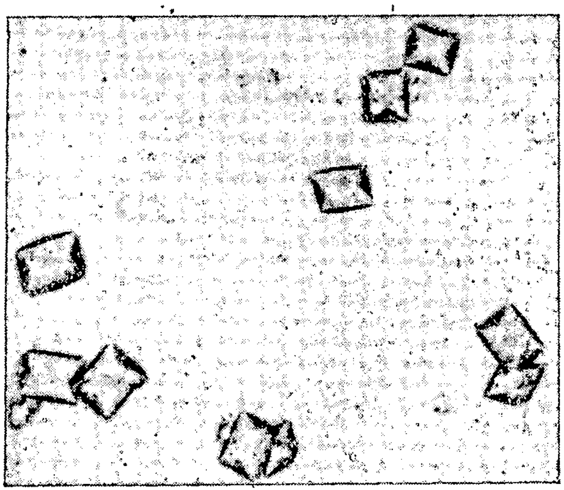
It is now fifty-four years since Gottstein[1] discovered that some bacteria are able to decompose hydrogen peroxide with evolution of gaseous oxygen, an activity he attributed to their possessing an intracellular enzyme which later came to be called 'catalase'. Since then much work has been done on bacterial catalase; but none of it has been directed towards elucidating the chemical nature of the enzyme and no attempts have been made to isolate it in a pure state from any micro-organism. A similar state of affairs exists in regard to the majority of the intracellular enzymes of bacteria, which have been little studied in comparison with their counterparts in animal tissues. One reason for this is undoubtedly the technical difficulty of liberating such enzymes from the bacterial cell. Most of the techniques hitherto used for destroying the cell wall and liberating intracellular enzymes (for example, autolysis, drying, shaking with glass beads or grinding with powdered glass, the roller-crushing mill, ultrasonic disintegration) either tend to be destructive of labile enzymes, are difficult to employ on a large scale, or require specialized apparatus.

A method having none of these disadvantages was first applied by Penrose and Quastel[2] in 1930, though it has been little used since; namely, lysis of bacteria by lysozyme[3]. This substance, which is easily prepared in crystalline form from egg-white[4], rapidly brings about smooth and complete lysis of susceptible bacteria; no specialized apparatus is required and the method can be applied on any scale.

Using this technique to liberate the enzyme, we have been able to isolate catalase from *Micrococcus lysodeikticus* in crystalline form. So far as we are aware, this is the first bacterial enzyme to have been crystallized. In outline, the technique of isolation is as follows. The bacteria are grown on C.C.Y. agar[5] in large enamelled trays, harvested, washed, suspended in 0·5 per cent sodium chloride, and lysed with crystalline lysozyme (1 mgm./gm. bacteria). The lysate is treated with 0·5 vol. alcohol at pH 5·6 in the cold, which precipitates large amounts of inert proteins and highly viscous substances formed on lysis. The supernatant liquid is shaken with 0·3 vol. chloroform which removes more inert proteins. Addition of ammonium sulphate (30 gm./100 ml.) to the supernatant liquid causes it to separate into two layers; the smaller top layer contains all the catalase. The chloroform treatment and 'layering' are now repeated, followed by dialysis to remove alcohol. The solution is now fractionated by step-wise addition of solid ammonium sulphate at pH 5·6; most of the catalase is precipitated between the limits 3·5–4 M, and is redissolved in about a tenth the original volume. It is now refractionated by careful addition of 4 M ammonium sulphate adjusted to pH 5·6. The main fraction is almost pure catalase; it is taken up in a minute amount of water and centrifuged; on standing at room temperature the enzyme crystallizes.

The crystals (see photograph) are always octahedra; no needle forms have been found. Identical crystals have been obtained by prolonged dialysis, but this is an inferior method as small amounts of protein impurity present are precipitated with the crystals.

Some bacterial enzymes (for example, lactic dehydrogenase) are known to have prosthetic groups different from their analogues in higher animals. Bacterial catalase, however, is remarkably similar to



CRYSTALLINE CATALASE FROM *M. lysodeikticus*. CRYSTALS FROM AMMONIUM SULPHATE. × *c.* 270

the crystalline catalases of horse, sheep and ox tissues.

The crystalline enzyme is an iron-porphyrin protein; its solutions have three absorption bands with centres at 6316, 5451 and 5060 A. Different preparations have contained 1·05–1·15 per cent hæmin (by direct estimation as pyridine-hæmochromogen). If the crystalline enzyme is pure, and contains four hæmin groups per molecule, the molecular weight is 226,000–248,000. Unlike animal liver catalases, all the prosthetic group is iron-protoporphyrin, and it appears to contain no verdohæmatin or similar substances producing blue pigments with acetone-hydrochloric acid. The enzyme has a greater activity than liver or blood catalase, the Kat-F.[6] being *c.* 90,000.

An interesting finding is the remarkably high concentration of catalase in *Micrococcus lysodeikticus*. From the catalase activities of the pure enzyme and the lysed bacteria, one can calculate that 100 gm. (dry weight) of this organism contain *c.* 2 gm. of catalase. Hence a single bacterial cell (dry weight taken as $2 \cdot 5 \times 10^{-13}$ gm.) contains *c.* 20,000 enzyme molecules. This amount of catalase would enable each cell to decompose about forty-seven times its own weight of hydrogen peroxide per minute (at 0° and a peroxide concentration of 0·01 *M*). Such large amounts of hydrogen peroxide could scarcely be formed as a result of cell metabolism, and it is difficult to devise any teleological explanation for this high enzyme concentration unless, as Keilin[7] has suggested, catalase has other functions besides the simple decomposition of hydrogen peroxide.

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April 29.

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[1] Gottstein, A., *Virchows Arch.*, 133, 295 (1893).

[2] Penrose, M., and Quastel, J. H., *Proc. Roy. Soc.*, B, 107, 168 (1930).

[3] Fleming, A., *Proc. Roy. Soc.*, B, 93, 306 (1922).

[4] Alderton, G., and Fevold, H. L., *J. Biol. Chem.*, 164, 1 (1946).

[5] Gladstone, G. P., and Fildes, P., *Brit. J. Exp. Path.*, 21, 161 (1940).

[6] Euler, H., and Josephson, K., *Ann.*, 452, 158 (1927); Sumner, J. B., *Adv. Enzymol.*, 1, 166 (1941).

[7] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, 119, 141 (1936).

Barium Titanate Crystals

CRYSTALS of barium titanate ($BaTiO_3$), with linear dimensions up to ~2 mm., have been produced from solutions in carbonates and chlorides, and (when pure) are hard, clear, pale yellow in colour, and of cubic external symmetry. We are greatly indebted to Prof. P. Scherrer, Zurich, for advice on methods of producing these crystals. The results of optical and X-ray examination of the crystals are summarized below.

At room temperature the crystals are piezo-electric (established in co-operation with Dr. W. A. Wooster, of Cambridge, using the apparatus of Giebe and Scheibe), and consist of individuals with tetragonal symmetry (space group *P4mm*), twinned about the 101 and 011 planes. The exact arrangement and size of the twins vary considerably, and depend upon the purity of the material and the stresses involved during their formation. In a simple case, the crystal consists of two sets of individuals twinned so that the tetrad axes are inclined at an angle of $90° - \gamma$, where $\gamma = 35'$ and $90° \pm \gamma$ is the angle between the diagonals of the 010 face of the tetragonal unit cell. The twin boundaries have lower birefringence and probably consist of stress-distorted, tetragonal cells which are very nearly cubic.

Above ~120° C. the crystals have cubic symmetry, *Pm3m*, and specimens can be taken through this temperature without structural breakdown; that is, the crystals maintain their rigidity and external form throughout the transition. The arrangement of the twins in the crystal below 120° C. may vary from one cycle of changes to the next, and provided no external stresses are applied, depends on the rate of cooling. Over a certain temperature-range near 120° C., both cubic and tetragonal phases co-exist in the same crystal.

The twin arrangement is sensitive to both electrical and mechanical stresses, particularly at temperatures near the transition (~120° C.), and also near 0° C. where the axial ratio c/a has a maximum value[1]. This accounts qualitatively for the maxima of incremental permittivity observed at these temperatures. On the application of such stresses the twins re-orient themselves so as to reduce the resultant internal stresses, and this is achieved by an increase in the proportion of the crystal volume occupied by those twins having the longer (polar) tetrad axis perpendicular to the applied mechanical stress (assumed compressive) or parallel to the applied electric stress. The increase in volume of any component is effected by a displacement of the twin boundary in a direction perpendicular to the plane of the boundary.

The ferro-electric characteristics of barium titanate have already been established by Hulm and others (see following communication), and our optical and X-ray diffraction studies enable us to associate the individual single-crystal components with ferro-electric domains; in some cases truly single crystals, assumed to consist of a single domain, have been observed at room temperature, but they tend to be unstable, especially just below 120° C.

Work is now in progress from which we hope to establish the exact atomic parameters in the unit cell of this and some allied materials, so providing the experimental basis for the theoretical discussion of the spontaneous electric polarization observed. We also propose to investigate in detail the behaviour of these materials at temperatures below room temperature, where other crystallographic changes have been noted.

A full account of these researches will be published later.

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R. G. RHODES

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Cavendish Laboratory,
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May 28.

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[1] Megaw, H. D., *Proc. Roy. Soc.*, A, 189, 261 (1947).

Dielectric Properties of Single Crystals of Barium Titanate

THE dielectric properties of some of the single crystals of barium titanate prepared by H. F. Kay and R. G. Rhodes (see preceding communication) have been measured at various field strengths and temperatures. The average linear dimension of the crystals available was 0·4 mm., and it was found convenient to mount them in thin disks of a phenol-formaldehyde resin. Silver electrodes were vaporized on to the two exposed faces, and the electrical contacts were pressed against the silver on the resin, so as not to stress the crystal. The electric field was applied along a direction which was a cubic axis above the Curie point, and contained a mixture of the three tetragonal axes, in various domains, at room temperature. A circuit essentially similar to that of Sawyer and Tower[1] was used to display the polarization-electric field curve at 50 cycles per second on a cathode ray tube.

Typical hysteresis loops obtained at various temperatures are shown in Fig. 1. Such loops were photographed for a series of maximum field strengths at each temperature, and the curve of maximum polarization against maximum field strength shown in Fig. 1 was derived. At 18° C. the curve rises steeply with increasing field and then gradually flattens. The region *AB* presumably corresponds to complete orientation of the ferro-electric domains in the field direction; its small gradient is of the same order as the weak field susceptibility found with a Schering bridge, and is perhaps due to ionic distortion. By extrapolating *AB* back to the polarization axis, the permanent polarization characteristic of a single domain in zero field may be estimated as about 16 micro-coulombs per sq. cm., which is much greater than that of the other known ferro-electrics. The permanent polarization values for other crystals examined agreed within about 10 per cent, which is the order of uncertainty in measuring the effective area used; the coercive field, however, varied widely between crystals, from about 5,000 to 20,000 volts per cm.

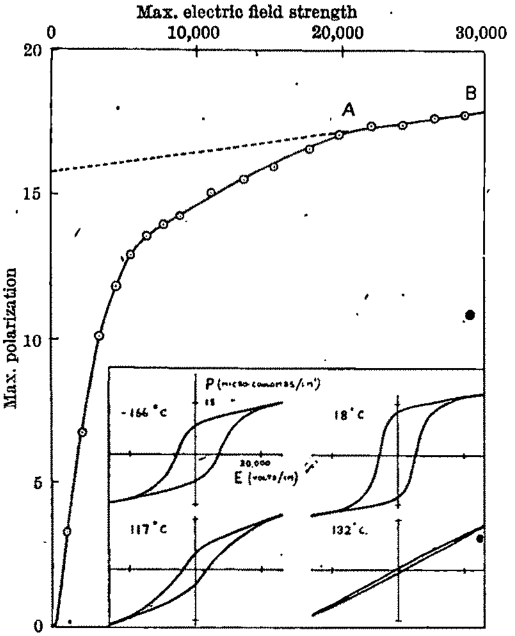

Fig. 1

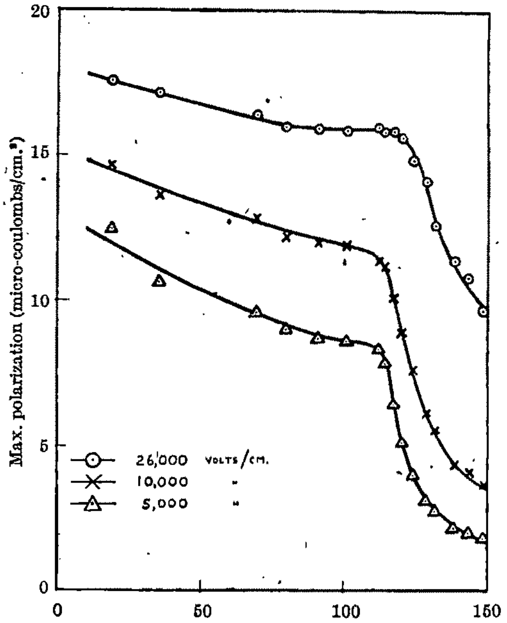

Fig. 2

Measurements on polycrystalline specimens by the same method show a maximum polarization of about 5·3 micro-coulombs per sq. cm. at 20,000 volts per cm., and similar results have been obtained by Wul and Goldman[2]. It is probable, however, that saturation for a polycrystalline aggregate is far from complete at this field strength, perhaps due to large internal strains which prevent complete alignment of domain directions in the fields available.

The behaviour of a single crystal at high temperatures is shown in Fig. 2, where maximum polarization is plotted against temperature for various field strengths. The polarization is fairly constant up to about 110° C., and then drops at a temperature slightly dependent on the field strength. Above about 130° C. the polarization – field relation becomes almost linear, though still corresponding to a very high dielectric constant which falls off according to a Curie–Weiss law. Estimation of the Curie temperature, at which hysteresis should disappear, is made difficult by an appreciable non-linear conduction above 100° C., which cannot be completely compensated and causes a slight apparent hysteresis. Detailed examination of the results suggests a Curie temperature of about 124° C., in good agreement with previous determinations on polycrystalline specimens[3].

Preliminary measurements down to 20° K. show that permanent polarization effects still exist at low temperatures; the coercive field is larger than at room temperature and the maximum polarization for a given field strength amplitude is smaller, probably due to incomplete saturation.

J. K. HULM

Royal Society Mond Laboratory,
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May 23.

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[1] Sawyer, C. B., and Tower, C. H., *Phys. Rev.*, **35**, 269 (1930).

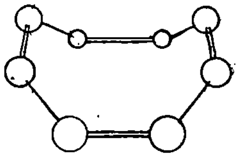
[2] Wul, B., and Goldman, I. M., *C.R. Acad. Sci. U.R.S.S.*, 51, 21 (1946).

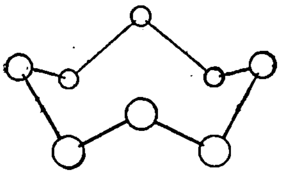
[3] Rushman, D. F., and Strivens, M. A., *Trans. Farad. Soc.*, **42** A, 231 (1946). Von Hippel, A., Breckenridge, R. G., Chesley, F. G., and Tisza, L., *Ind. and Eng. Chem.*, **38**, 1097 (1946).

The 'Octa-Benzene', Cyclo-octatetraene (C_8H_8)

THE fact that cyclo-octatetraene—in contrast to benzene—shows a markedly unsaturated character has generally been used as an argument in favour of the assumption that the molecule contains alternate double and single bonds. The resonance energy, which is not much smaller per CH-group than that of benzene, makes the correctness of this assumption seem rather doubtful. On the other hand, a preliminary Raman analysis leads E. R. Lippincott and R. C. Lord, jun.[1], to believe that the spectrum can best be interpreted on the basis of a puckered eight-membered ring with alternate single and double bonds.

An electron diffraction analysis of the vapour carried out recently, using the sector method, leads to a different conclusion. This analysis indicates that all the C—C bonds are equivalent, and that the C—C—C angles are 120° just as in benzene. The C—C distance is not much greater than that of benzene (about 2 per cent).


a


b

The distribution curve ($\sigma(r)/r$) directly obtained from experiment was compared with theoretical curves based on the following models: (1) plane ring, (2) puckered ring with alternate double and single bonds, (3) puckered ring with equivalent bond, varying the C—H distance within a reasonable range. In case 3 only was satisfactory agreement obtained. The carbon skeleton of a model based on the assumption of alternate double and single bonds is reproduced in Fig. *a*, the carbon ring of the model resulting from the electron diffraction investigation in Fig. *b*. (It is, of course, possible that the bonds of Fig. *b* are not strictly equivalent. In this case, however, the difference between the two types of bonds is too small to be detected interferometrically.)

The 120° angle between C—C bonds indicates the presence of σ-bonds (ps^2-bonds). The additional π-bonds are based on p-orbitals perpendicular to the plane of the σ-bonds. The overlapping of two neighbouring p-orbitals is weaker than in the case of benzene because their directions are no longer parallel. It may thus be understood that the C—C distance is greater and the unsaturated character more pronounced than in the case of benzene.

We have further reinvestigated the Raman spectrum of cyclo-octatetraene. Our measurements in the frequency region below 2,000 cm.$^{-1}$ (that is, excluding the complicated region of hydrogen-stretching frequencies) are given in the accompanying table.

Frequency (cm.$^{-1}$)	Intensity	Polarization	
200 (broad)	8	*P*	
254	3	*D*	
298	3	*D*	
370	6	*D*	
659	1	*D* ?	
876·8	8	*P*	
953	4	*D*	
1209	6	*D*	
1220	2	*D* ?	
1442	6	*D*	
1459	0	—	1209 + 254 = 1463
1608	1	*D* ?	
1639	2	*D* ?	1442 + 200 = 1642
1655·5	10	*P*	
1748	0	—	2 × 876·8 = 1754

In agreement with Lippincott and Lord[1], we have found only three of the Raman lines to be polarized. We have, however, failed to observe several frequencies reported as weak lines by these authors. As seen from the table, three of the fifteen Raman lines observed by us may be explained as combination tones, leaving twelve frequencies to be interpreted as Raman active fundamentals. This is in agreement with the D_{4d} symmetry which requires three polarized and nine depolarized Raman lines in this frequency region. As a D_4 or a D_{2d} structure should give rise to five polarized and 18 resp. 17 depolarized lines, we believe that the Raman spectrum can best be interpreted on the basis of the D_{4d} model.

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[1] Lippincott, E. R., and Lord, jun., R. C., *J. Amer. Chem. Soc.*, **68**, 1868 (1946).

A Pulse Method for the Measurement of Ultrasonic Absorption in Liquids: Results for Water

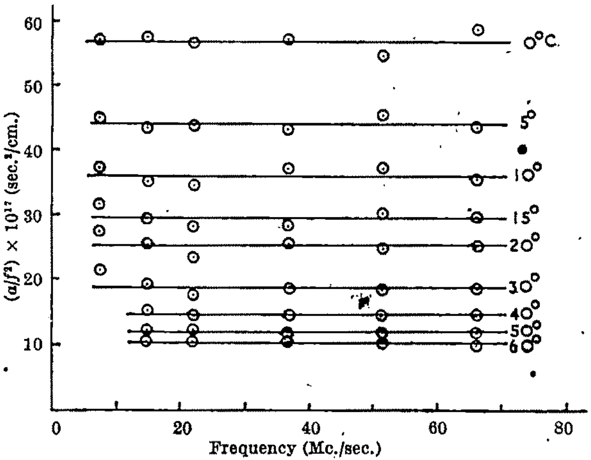
IT is well known that measurements of the absorption of ultrasonic waves in liquids[1-3] often do not show good agreement, and that for numerous liquids they indicate absorption coefficients many times those calculated on the assumption of a purely viscous loss. Because of these discrepancies it was considered useful to make measurements by a new technique, and one was chosen which would remove many of the possible objections to previous methods. A 'radar pulse' technique was developed, in which a short wave-train was emitted in a narrow pencil from a quartz oscillator; the sound, after travelling through the liquid, was reflected and received by the same quartz plate, which thus acted as a common 'transmit–receive' transducer.

The amplitude of the received pulse was measured as a function of the distance to the reflector. By driving the quartz crystal on its fundamental and 3rd, 5th, 7th and 9th harmonics, it was possible to measure absorption of waves on five frequencies from 7·37 to 66·1 Mc./s. A sixth frequency, 15 Mc./s., was added by changing the crystal. A feature of the technique was the elimination of errors due to diffraction; concordant measurements were made in both the Fraunhofer and Fresnel diffraction zones of the quartz disk. In the case of small absorption, that is at low frequencies, the reflector was placed in the Fraunhofer zone and the results suitably corrected[4]. It is not clear from published descriptions that due care in this connexion has always been taken in previous work.

The most important advantages of the pulse method arise from (*a*) the small mean powers which may be used, (*b*) the fact that waves which have travelled by different paths can be distinguished by the difference in their time of arrival. Many of the previous methods, especially those based on acoustic radiation pressure, require a comparatively large power, which leads to heating of the liquid, the production of cavitation, and 'streaming' of the liquid. In the pulse technique the mean power, responsible for the phenomena just described, may be kept very small; in these experiments it was about one milliwatt. Moreover, in methods employing continuous waves, it can never be entirely certain that some of the effects attributed to energy loss in the liquid (true absorption) are not due to loss of energy by scattering out of the beam. The pulse method is particularly suitable for the detection of scattered radiation, and it was easy to show that no measurable intensity of sound was scattered backwards from the liquid in front of the crystal. In addition, a direct test, using a separate receiving crystal, was made to see if any energy was scattered sideways out of the beam in water. This test showed that any loss of energy from the beam due to scattering is negligible.

The electrical method used for determining the amplitude of the received pulse permitted measurement over a much wider range than had previously been possible by other means.

The duration of the pulse was variable from 2 to 40 microsec. and the repetition frequency was 250 c./s. The received pulse was displayed after amplification on a time-base on a cathode ray tube, and an accurately adjustable set of timing marks was provided for velocity measurement if required. In order to measure the amplitude of the echo, a comparison signal was injected from a pulsed signal generator on the same frequency as the sound wave. A double-walled trough 5 ft. long contained the liquid, which was stirred vigorously; in the outer jacket, water was circulated rapidly from a thermostat. Above the trough was mounted an optical bench, fitted with a centimetre scale and sliding carriage to move the reflector. Independent fine adjustments could be made to the position of the crystal housing and reflector.



VARIATION OF α/f^2 WITH TEMPERATURE AND FREQUENCY

Measurements have now been made in water between 0° and 60° C. at 7·37, 15·0, 22·1, 36·9, 51·6 and 66·1 Mc./s. According to the theory of Stokes[5], the amplitude absorption coefficient α should be given by

$$\frac{8\pi^2\eta f^2}{3\rho v^3}.$$

If this formula holds, a plot of α/f^2 against f would be a straight line parallel to the f axis; the accompanying figure shows values of α/f^2 measured at six frequencies plotted against f for various temperatures of the water. It is seen that α/f^2 is constant within experimental error. The experimental value of α/f^2 is, however, larger than that given by the Stokes theory, as the following table shows:

Temperature	α/f^2 (sec.²/cm.) mean of observed values	α/f^2 (sec.²/cm.) calculated	$\frac{\alpha_{obs.}}{\alpha_{calc.}}$	Probable error (%)
0° C.	$56{\cdot}9 \times 10^{-17}$	$17{\cdot}09 \times 10^{-17}$	3·33	±0·6
5	44·1	13·40	3·29	±0·6
10	36·1	11·34	3·18	±0·86
15	29·6	9·59	3·09	±0·9
20	25·3	8·16	3·10	±1·35
30	19·1	6·15	3·10	±1·7
40	14·6	4·85	3·01	±0·5
50	11·99	3·98	3·01	±0·4
60	10·24	3·36	3·04	±0·8

The ratio of $\alpha_{obs.}$ to $\alpha_{calc.}$ is strikingly constant over a wide range of temperatures, although α itself changes considerably. The probable error of α/f^2, as judged from the variations about the straight lines drawn in the figure, does not exceed 1·7 per cent. It is noteworthy that the ratio $\alpha_{obs.}/\alpha_{calc.}$ shows a rise in the range 0–10° C., in which it is known that changes of structure occur in water.

(After some of the measurements had been made, a copy of the paper by Pellam and Galt[6] became available in which measurements with an essentially similar apparatus are described.)

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April 24.

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[1] References to earlier work can be found in Richards, W. T., *Rev. Mod. Phys.* **11**, 36 (1939).

[2] Fox, F. E., and Rock, G. D., *J. Acoust. Soc. Amer.*, **12**, 505 (1941); *Phys. Rev.*, **70**, 68 (1946).

[3] Teeter, C. E., *J. Acoust. Soc. Amer.*, **18**, 488 (1946).

[4] Born, H., *Z. Phys.*, **120**, 383 (1942–43).

[5] Stokes, G. G., *Trans. Camb. Phil. Soc.*, **8**, 287 (1845).

[6] Pellam, J. R., and Galt, J. K., *J. Chem. Phys.*, **14**, 608 (1946).

Thermionic Properties of Thoria

It may be of interest to record our recent results on the thermionic properties of thoria coatings and of thoria in bulk. In the first experiments, a coating of thoria about 0·1 mm. thick was formed on a tantalum strip by spraying. The spraying suspension was made using an organic binder and solvent, as employed in standard techniques with barium–strontium carbonates. Direct current and pulsed emission were studied in a simple diode the anode of which could be water-cooled. The thoria surface temperature was estimated from pyrometer measurements assuming a spectral emissivity of 0·35 over the temperature range 1,800°–2,100° K.

Emission was at once available after outgassing, but rose by a factor of 3 or 4 during activation at temperatures from 2,000° to 2,100° K. Richardson plots were made of the saturated emission in the steady state, applying the formula $I = AT^2 \exp(-e\varphi/kT)$. These gave a mean value for the work function of 2·5(4) eV. in the D.C. experiments, and a mean value of A of 2·5, corresponding with an emission of 2·5 amp./cm.^{2} at 1,900° K. Higher saturated emissions were obtained under pulsed conditions, giving a work function of 2·6(2) eV. and a value of A of 7·5. Diodes were operated for 500 hours under D.C. conditions at temperatures from 1,950° to 2,050° K., taking currents of 3–7 amp./cm.^{2}. The emission fell in all cases, more rapidly at the higher temperatures, and at a rate which did not appear to depend on current density at a given temperature. In contrast with the behaviour of thoria coatings investigated by Weinreich[1], there was no rise in work function during operation, the whole of the decrease in emission corresponding with a decrease in value of A. The coatings remained white throughout, probably because the temperature was not raised above 2,200° K. A typical effect was a fall in saturated emission from 6·0 to 4·5 amp./cm.^{2} in 500 hours at 2,000° K.

Very similar results were obtained when cathodes were prepared by sintering a layer of tungsten powder on a tantalum strip, and painting the thoria coating into the sintered layer. This procedure is of American origin, and has been described, for example, in British Patent Specification No. 568962. The activation, work function and behaviour during prolonged D.C. operation were not distinguishable from the results with the sprayed coating; the mean value of A was, however, somewhat lower. This process avoids problems of adhesion which are encountered with the sprayed coatings, probably because there is little, if any, chemical reaction between tantalum and thoria below 2,200° K., the maximum temperature so far employed in cathode processing. With both types of cathode at 2,100° K., currents have been drawn of 10 amp./cm.^{2} under D.C. conditions and 30 amp./cm.^{2} under pulsed conditions, with none of the breakdown effects ('sparking' or 'flashing' between anode and cathode) which are commonly encountered with barium–strontium oxide coatings.

In the second series of experiments, a thoria cathode was made in the form of a tube by extrusion and sintering. The tube, of wall thickness 0·5 mm., was heated indirectly using a central tungsten wire heater-spiral. Emission was available at once after outgassing, and activation for a short time produced a stable emission which was studied under pulsed conditions. The work function was 2·5(5) eV. and the mean value of A 3·5, corresponding with a saturated pulsed emission of 3·6 amp./cm.^{2} at 1,900° K. The emission fell rather rapidly in the only diode so far operated over a long period, by about 40 per cent in 200 hours while drawing saturated pulsed emission at 1,930° K. In addition, a cathode of this type is sensitive to thermal shock, and cracks have developed after operation for periods varying from 20 to 250 hours.

The resistivity of the thoria as used in the tube cathodes was measured approximately, and found to be of the order of 30 ohm-cm. at 1,900° K. The resistance increased exponentially as temperature was lowered, with an activation energy of 1·1 eV. If the thoria coating had similar resistivity, in the first experiments, the resistance per cm.^{2} of the coating would be about 0·3 ohm at 1,900° K., which is about a tenth of the resistance of barium–strontium oxide at 800° C. This may explain the greater freedom from breakdown effects. In addition, there is reason to believe there is not a significant potential barrier at the metal-semiconductor boundary, so that the voltage drop is uniform through the coating and not concentrated near the boundary as in barium–strontium oxide coatings.

The watts radiated from a thoria surface at 1,900° K. were about 40 watts/cm.^{2}, corresponding with thermal emissivity 0·5(3). From this figure the emission efficiency in milliamperes per watt can be determined.

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[1] Weinreich, *Rev. Gen. Elec.*, 54, 243 (1945).

Use of the Cathode Ray Oscillograph for Studying the Near Infra-Red Solar Spectrum

AN apparatus has been developed in the Radiation Laboratory of the Meteorological Office at Poona for the measurement of absorption due to atmospheric water vapour in the near infra-red region of the solar spectrum by means of a cathode ray oscillograph. The working principle of this apparatus and the object for which it was developed are entirely different from those described by Daly and Sutherland and by King, Temple and Thompson[1], and it was developed independently of their work. A short paper describing it was read by me at the symposium on "Atmospheric Processes" held at the Royal Institute of Science, Bombay, under the auspices of the National Institute of Sciences of India in August 1946. This paper is at present in course of publication in a special issue of the *Transactions of the National Institute of Sciences of India*.

Work was started on this apparatus towards the end of January 1946. In the first model, which was ready by the middle of May 1946, an electrically maintained oscillating slit was used for scanning the image of the solar spectrum formed by a spectroscope. This slit was maintained in a steady state of oscillation by mounting it on a steel reed tuned to a frequency of 50 c./s., and was excited by means of an electromagnet supplied with 50 c./s. alternating current from the mains. The light passing through the slit was received by a cæsium oxide-on-silver photo-electric cell with a quartz envelope. The output of the photo-cell was amplified and applied to the vertical deflecting plates of a cathode ray tube. A 50-c./s. sinusoidal voltage obtained from the A.C. mains was fed to the horizontal plates of the cathode ray tube after passing it through a phase-shifting network. Thus the vertical displacement of the cathode ray spot was made dependent on the intensity of light passing through the slit; and the horizontal displacement was synchronized with the simple harmonic motion executed by the oscillating slit, and therefore it corresponded to the wave-length in the spectrum being scanned. Thus the cathode ray spot traced on the fluorescent screen a graph of light intensity against wave-length in the region of the spectrum being scanned by the oscillating slit.

Fig. 1 gives an idea of the performance of the apparatus in its present form, in which the oscillating slit has been replaced by a rotating disk with a number of identical slits. It shows the pattern produced on the cathode ray tube screen when the

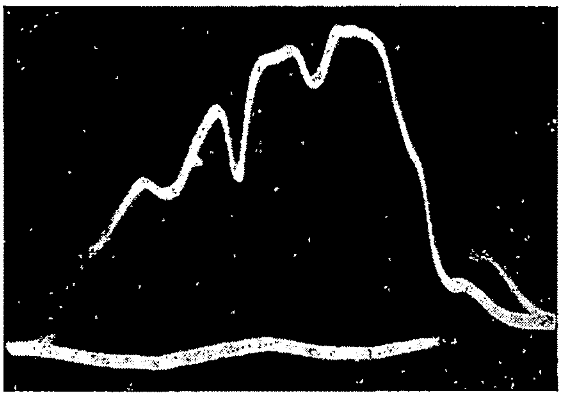

Fig. 1. ABSORPTION BANDS DUE TO WATER VAPOUR AND OXYGEN IN THE EARTH'S ATMOSPHERE

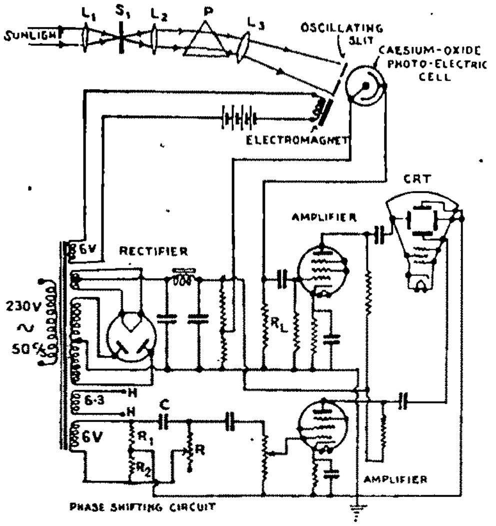

Fig. 2. CIRCUIT DIAGRAM OF CATHODE RAY TUBE SPECTROGRAPH

region between $0{\cdot}75\ \mu$ and $1{\cdot}3\ \mu$ in the near infra-red region of the solar spectrum was being scanned on a clear afternoon in January 1947. The absorption bands which can be seen in the photograph are, from left to right: oxygen band at $0{\cdot}76\ \mu$, ρ band (H_2O) at $0{\cdot}93\ \mu$ and φ band (H_2O) at $1{\cdot}13\ \mu$. Fig. 2 is a schematic circuit diagram of the apparatus.

This apparatus was developed for the rapid estimation of the total precipitable water vapour in the atmosphere. Its spectral range is limited to the visible and some portions of the near ultra-violet and near infra-red regions of the solar spectrum; the limiting factors being the transmission characteristics of the spectroscope optics, which are of glass, and the sensitivity of the photo-cells, which is restricted to the region between $0{\cdot}34\ \mu$ and $1{\cdot}5\ \mu$. A detailed account of the apparatus will appear elsewhere.

I wish to express my thanks to Dr. L. A. Ramdas, director of agricultural meteorology, Meteorology Department, Government of India, for guidance and for providing the necessary facilities for the work.

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c/o Radiation Laboratory,
Meteorological Office,
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April 23.

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[1] Daly, E. F., and Sutherland, G. B. B. M., *Nature*, 157, 547 (1946); King, J., Temple, R. B., Thompson, H. W., *Nature*, 158, 197 (1946). See also *Nature*, 153, 591 (1946).

Interaction of Styrene with Magnesium Perchlorate and Other Salts

IN connexion with an investigation into the mechanism of Friedel-Crafts reactions involving styrene, we required a supply of this olefin of maximum possible dryness[1]. Before proceeding to drying by evaporation in an all-glass high-vacuum apparatus of the Stock type, a preliminary treatment with magnesium perchlorate ('Anhydrone') was given. We found, however, that polymerization was induced by this drying agent: in three weeks a highly viscous polymer was obtained.

This effect can be attributed to several mechanisms. It may be due to oxygen derived from the perchlorate, to perchloric acid generated hydrolytically, or to a co-ordinating action of the magnesium atom[2]. Organic complexes of magnesium perchlorate are known, as with dioxan, while styrene forms complexes with, for example, platinum chloride[3].

To test these views in a preliminary way styrene (*a*) dried over sodium sulphate and (*b*) saturated with water, was treated with magnesium perchlorate and magnesium chloride hexahydrate. The 'dry' perchlorate system showed 13 per cent polymerization in 48 hours: the 'wet' system 6 per cent; both as judged by estimation of residual monomer using a method based on the work of Williams[4] and Mulliken and Wakeman[5].

With magnesium chloride the effect is much slower, but the 'dry' olefin is converted to a viscous polymer in two months. 'Wet' styrene is largely unaffected in the same time. This last observation may be connected with the preferential formation of phenyl ethyl chloride, much as the reduced polymerization in the 'wet' perchlorate system may be due to hydroxylation—comparable with the acetylations induced by the Bertram-Walbaum and similar reagents[6].

We have further found that anhydrous calcium sulphate, which has been recommended for drying styrene, promotes polymerization after prolonged induction periods.

The above preliminary notes do not allow us to distinguish the mechanisms of polymerization involved, which we propose to elucidate by kinetic studies using a wide range of inorganic salts. In this way we hope to obtain information about the mode of action of free radical or electrophilic catalysts, and possibly uncover new examples of the latter type.

In the meantime, we wish to indicate that it is not safe to use magnesium perchlorate for the drying of styrene, and hence probably for drying other olefins. Further, it is probably not safe to leave this olefin in contact for more or less prolonged periods with salts which can exhibit co-ordination, or which can yield strong hydrogen acids by hydrolysis.

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April 21.

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[1] See, for example, Polanyi *et al.*, *J. Chem. Soc.*, 252 (1947).

[2] Lewis, G. N., *J. Franklin Inst.*, 226, 293.

[3] Anderson, J. S., *J. Chem. Soc.*, 971 (1934); 1042 (1936).

[4] Williams, G., *J. Chem. Soc.*, 1046 (1938).

[5] Mulliken, S., and Wakeman, H., *Ind. Eng. Chem., Anal. Ed.*, 7, 59.

[6] See, for example, Lennartz, *Ber.*, 76, 831. Farmer and Pitkethly, *J. Chem. Soc.*, 11 (1938).

THE NATIONAL PHYSICAL LABORATORY

ANNUAL INSPECTION

REPRESENTATIVES of industrial organisations, university staffs and leading Government men of science were once again invited to inspect the work which is in progress during the National Physical Laboratory's 'open days', June 18–20. This second post-war exhibition followed the annual inspection by the Laboratory's General Board, of which the president of the Royal Society is chairman. Altogether, 264 exhibits were on show, illustrating the variety of work undertaken in the Laboratory's ten Divisions, and during the three days some two thousand people visited the Laboratory.

The National Physical Laboratory has grown steadily throughout its forty-six years of existence and now comprises sixteen large and a number of small buildings on a site of 60 acres. Until 1918, it was under the control of the Royal Society and, although since that date the Laboratory has been part of the then constituted Department of Scientific and Industrial Research, the Society still advises on the scientific aspects of the work.

The main aspects of the work of the Laboratory are the carrying out of research, including especially research required for the accurate determination of physical constants, the establishment and maintenance of precise standards of measurement, and the testing of instruments and materials. It also undertakes investigations of special problems on behalf of Government departments, for research associations representing various industries, and for technical institutions, industrial firms and others.

To describe any considerable number of exhibits in a short article such as this would be impossible, and mention will be made only of those items which are of outstanding general interest or which illustrate some interesting new development.

Of considerable interest to structural engineers is the research being carried out on the wind-induced oscillations of the proposed Severn suspension bridge, the centre span of which will be more than 3,000 ft. in length. The Tacoma Narrows Bridge in the United States, which collapsed in 1940 under torsional oscillation, had a centre span 2,800 ft. long. Dynamic scale models more than 80 ft. in length are being constructed for tests in a large wind tunnel specially built by the Ministry of Transport, and the structural components of these models were on view. In this tunnel, a special turntable will enable tests to be made on the model bridge at all horizontal angles of wind incidence, with wind speeds up to a maximum corresponding to 130 m.p.h. on full scale.

A more stable type of hot-wire anemometer for measuring wind speeds of less than 2 ft. per second has been recently developed at the Laboratory. In this instrument the heater wire and the thermocouple wires are carried in a twin-bore silica tube, which acts as a shield preventing deposition of extraneous matter on the wires. Considerable use has already been made of this instrument in various investigations, and it will find a ready application in such work as the ventilation of mines and buildings.

The Engineering Division had on show the results of work carried out in connexion with the adoption of a new standard thread-form by Great Britain, Canada and the United States. The major portion of this work had been completed in time for the Conference on the Unification of Engineering Standards in Ottawa in 1945, which decided upon the new form of thread to be recommended.

This Division of the Laboratory has given considerable help in the recent development of gas turbines. Work on the development of suitable bearings for use at the very high rotational speeds required, and the investigation of the fatigue and creep properties of various alloys, are of outstanding importance in this respect.

The tidal model work is now concerned with the Firth of Forth, and a model of the estuary has been constructed to a horizontal scale of 1 in 1,800. The main purpose of the investigation is the study of the deposition of silt in the approaches to Rosyth Dockyard, the dredging of which entails considerable expense. A model of the estuary of the River Wyre in Lancashire is under construction for the study of problems connected with the meanderings of the deep-water channel.

In the Electricity Division the determination of the velocity of electromagnetic waves is being made by measuring the frequency of electrical resonance of a hollow copper cylinder. This frequency depends only on the dimensions of the cylinder and the velocity of propagation of the waves, and an error of less than three hundred thousandths of a centimetre in the measurement of the dimensions allows an estimated accuracy of 9 km./s. in the determination of the velocity.

The High Voltage Laboratory had an exhibit illustrating the progress that has been made in the design and construction of an absolute voltmeter for very high voltages. This attracted-disk type of voltmeter will be housed in a compressed gas chamber, and with its development it is hoped to acquire experience of the properties of compressed gases as high-voltage dielectrics.

The quantitative study of the propagation of centimetre waves has required the development of suitable field-strength meters and standard radiators. The equipment displayed was designed for operation at wave-lengths of about 10 cm. and 3 cm., and consists essentially of antennæ of known gain (determined experimentally) relative to a half-wave-length dipole. In this sphere, a knowledge of the dielectric properties of the atmosphere and its constituents is needed for a full understanding of the propagation processes, and apparatus for the measurement of the reflexion and transmission coefficients of water at wave-lengths down to nine millimetres was also on view. The waves are reflected or transmitted through very thin plane sheets of water, and measurements on the effect of salt in solution have enabled a comparison to be made between the properties of sea- and fresh-water.

One of the interesting instruments on view was a photo-electric colorimeter employing an adjustable spectrum template. The three separate curves which measure and express the colour functions of the eye are not exactly the same for every individual, so that it has been necessary to provide an agreed set of average curves, which has been given the status of 'international standard observer'. The instrument consists of a photocell and the means to modify the response to that of the average observer. It has a wider application than the spectrophotometer, being capable of measuring not only absorption on coloured glasses or paper, but also illuminants such as discharge lamps and any colour illuminated by them. The accuracy with which the combination of photocell and colour filter gives the same results as the average eye is being investigated.

During the past year an entirely new section, on control mechanisms, has been added to the Metrology Division. This group has in hand the development of an electro-mechanical differential analyser. This machine will have twenty mechanical integrators and gear systems, interconnected by electrical remote control position servo-mechanisms, which will enable it to be used either as a whole or in sections permitting the simultaneous solving of several problems. A prototype model comprising two integrators was on view. The section is also concerned with the study of the principles of automatic control, and a pilot plant has been designed and constructed for this purpose. Oil is circulated through the plant and its temperature automatically controlled by closed-cycle systems employing the proportional, the floating (or integral) or the first derivative (or rate) method of control. Alternative control methods will also be investigated.

Ternary alloys of iron, nickel and chromium form the basis of numerous commercial alloys for use at service temperatures between 500° and 800° C. It is desirable—in many cases essential—that exposure to these high temperatures should not bring about any micro-structural changes which might be accompanied by a deterioration in the mechanical properties of the alloys. One such possible change is the formation of the brittle sigma phase in alloys of certain compositions when heated within the 500°–800° C. range, and the composition and temperature ranges over which this phase is precipitated in pure iron–nickel–chromium alloys is under investigation in the Metallurgy Division. One of several interesting points shown by this work is the extreme sluggishness of the process by which the sigma phase is formed in alloys containing about 20 per cent chromium, and the effect of increasing proportions of nickel on the sluggishness of the reaction. The indications are that alloys containing about 20 per cent of chromium and not less than 25 per cent of nickel will only attain true equilibrium after many months annealing at temperatures between 550° and 650° C.

Two new induction furnaces to be added to the equipment of the Division will be used in the first place to make alloys for studying the effects of alloying elements on the properties of pure iron. One furnace, designed to melt at least 50 lb. of iron in air, has already been installed, and a second furnace designed to melt 25 lb. of iron *in vacuo* is at present under construction.

The Ship Division, working in close collaboration with the principal shipbuilders and naval architects, is rendering very useful service in solving difficulties with regard to ship-form design, and models of all classes of ships, ranging from 30,000-ton liners to 45-ton launches, are tested in one or other of the two tanks. As a result of such tests, corrections to improve performance are made in the ship and, in many cases, a final check is carried out by staff during an actual voyage. Various pieces of apparatus used in these full-scale tests at sea were on view, and hull-form tests and propulsion experiments were being carried out in the tanks.

Modern requirements as regards comfort in buildings coupled with the necessity for fuel economy have led to an intensive study of the properties of walls, roofs and floors as regards resistance to heat flow. The Physics Division of the Laboratory displayed a wide range of equipment of this nature for dealing with, say, wall-sections weighing half a ton or thin sheeting materials such as wall-boards. Work is also carried out on wall-sections of cavity construction when the external surface is subjected to a daily cycle of radiation simulating conditions in the tropics. The uniform stream of radiation is supplied by a battery of incandescent lamps run at low filament-temperature and mounted in parabolic reflectors.

Since the War, fundamental work on acoustical measurement standards has been recommenced and the section concerned has been largely re-equipped. A new development on view this year was a large acoustic duct in which plane waves of sound are generated to serve for the standardization of microphones at low frequencies and for other experiments involving low-pitched sounds.

One of the sections of the Mathematics Division, that concerned with research into new computing methods and machines, is now engaged in the development of an automatic computing engine, the ACE, and a short lecture on electronic computing machines was given twice on each afternoon during the exhibition. A correlogram calculator constructed at the Laboratory was on view. This instrument is used for calculating serial correlation coefficients direct from a continuous graphical record, and uses three pairs of wheel and disk integrators linked together by an averaging motion.

THE CHEMICAL RESEARCH LABORATORY, TEDDINGTON

REPRESENTATIVES of all elements of the chemical community and including many distinguished foreign men of science have recently visited the Chemical Research Laboratory of the Department of Scientific and Industrial Research. These 'open days' coincided with the centenary celebrations of the Chemical Society, and a large party of fellows of the Society visited the Laboratory on July 17.

The Laboratory, founded in 1925 to provide a centre for the fundamental chemical research carried out in the Department of Scientific and Industrial Research, stands in the same grounds as the National Physical Laboratory. If it has not yet achieved the wide fame of its older and larger sister, it has shown a sturdy growth during its short life and, with the ending of its war-work, is entering upon a period of vigorous activity.

Since the end of hostilities, the Laboratory has been modernized and re-equipped. A large prefabricated building has been erected during the past few months and is in full use. The new building has been named after Stephen Hales, to commemorate this great experimental scientific worker who was, for more than fifty years, vicar of Teddington. Much of the existing building has been overhauled and modified to accommodate new techniques. These include micro-analysis, high-efficiency fractional distillation, spectrography and many more. The existing facilities in such major fields as the corrosion of metals, high-pressure reactions and plastics have been improved and extended.

The buildings contain sixty-five rooms of various sizes, of which eleven are specialist laboratories and three semi-scale laboratories. The Laboratory also has a drawing office, two workshops and a glass-working room manned by skilled staff who are engaged on the design, production and maintenance of the apparatus required in the various researches.

The programme of the Laboratory is undertaken on the advice of the Chemistry Research Board, the present chairman of which is Sir Norman Haworth. In addition to its own research programme, the Laboratory collaborates with other stations of the Department of Scientific and Industrial Research, including the National Physical Laboratory, the Fuel Research Station, the Forest Products Research Laboratory, etc., and carries out research for other Government departments. At present problems are under investigation for the Admiralty, the Ministry of Supply, the Board of Trade and the Agricultural Research Council.

The results of the Laboratory's researches are communicated to the Departments concerned, and to British chemical industry, as well as being published in the usual scientific journals. Special reports are also issued. General reviews have appeared for the period up to 1934; for 1934–37; and a review for the years 1938–46 is in the press.

The Laboratory, which is under the direction of Prof. R. P. Linstead, is organised in five main sections: corrosion of metals; inorganic; coal tar; high polymers and plastics. Provision is also made for exploratory and special work. Some past achievements of the Laboratory and a brief outline of its present work follow.

Corrosion, and particularly the rusting of iron and steel, cause losses of many millions of pounds per annum. This is not only a question of expense but also involves depletion of a natural resource which is not being renewed. It is, therefore, fitting that study of corrosion of metal and its prevention should have an important place in the programme of a laboratory established for the general benefit.

The formation of surface films by metals is a well-known phenomenon. The anodic oxidation of aluminium, discovered by this group of workers, involves a deliberate thickening of the film that forms naturally on this metal. A method of stripping films from metal, devised by Dr. U. R. Evans and improved at the Chemical Research Laboratory, has enabled the invisible films from metals such as stainless steel to be removed and analysed.

Corrosion of metals immersed in salt- or fresh-water is studied under static conditions, and when the samples are rotated at low and at high speeds. The rotor test devised at the Laboratory, although primarily designed for fundamental studies, found an immediate application on the outbreak of war in the evaluation of protective coatings for ships. Electrochemical methods now show great promise in determining the breakdown of paint films in immersed conditions. Atmospheric corrosion is especially important in relation to the present building programme, and attention is being given to the development of accelerated tests of painted surfaces. Some kinds of underground corrosion are due to the influence of bacteria. These micro-organisms are anaerobic and the damage occurs in clay or water-logged soil. The microbiological group of the Laboratory is at present concentrating on a study of these bacteria.

The experience gained in these researches on corrosion often enables the staff to assist in solving *ad hoc* problems by advice or investigation. Sometimes such work leads to useful discoveries. For example, war-work on anti-freeze materials led to the discovery of the remarkable inhibitive properties of sodium benzoate both in aqueous solution and when incorporated in wrapping materials.

Prior to the War, the Inorganic Section was investigating flue dusts and ashes as sources of semi-rare metals, but during the War special investigations were undertaken on behalf of the Ministry of Home Security. The successful outcome of one of these was the production of a fire foam agent from a cheap and indigenous source, as well as the provision of valuable fundamental information on the physical properties of foams. The possibility of making an entirely satisfactory carbon black from indigenous products was also demonstrated by this Section on a pilot-scale plant. Work on semi-rare metals has now been resumed on a broader basis. Some quantity of gallium metal and germanium halides have been prepared from indigenous material and are available for experimental work on possible useful applications.

Investigation of the composition of the tars produced by low-temperature carbonization of coal was started in 1925. The Coal Tar Section devised a scheme of separating groups of tar constituents by low-boiling solvents and dilute aqueous solutions avoiding the use of high temperatures. By this means comparative figures for tars from different sources were obtained and interesting products separated. One of these, a high-boiling tar-phenol fraction, proved very effective as a wetting agent in the mercerization of cotton, and was produced commercially as 'Shirlacrol'.

The Section is now concerned with the isolation and identification of tar constituents, using the most refined methods of separation and technique, such as high-efficiency fractionation combined with azeotropic distillation, of which a special study is being made. Allied to this is the determination of the physical and physico-chemical constants of pure coal-tar products by the most accurate methods available. Another objective is to find new uses for tar constituents or derivatives. For example, acenaphthene has been dehydrogenated to acenaphthylene, which, on polymerization or co-polymerization with styrene, yields polymers having interesting and promising characteristics.

Research on synthetic resins was one of the original topics in the programme of the Laboratory, and an outstanding contribution was the discovery of the ion-exchange resins, which has led to the establishment of a new branch of the plastics industry and to a new industrial technique. During the War, work was directed to immediate requirements, notably of the Ministry of Aircraft Production, such as the production of light-weight material using expanded resins, laminated boards and synthetic adhesives.

The High Polymer and Plastics Section is now engaged in fundamental studies of the relationship between chemical structure and the physical and physico-chemical properties of high polymers and plastics. Among the subjects under investigation are the development of improved synthetic glues and a fundamental study of ion-exchange resins with the view of producing a material of increased capacity or utility.

Pioneer work on high-pressure reactions, in the years following the founding of the Laboratory, resulted in the construction of apparatus and the discovery of catalysts by which aliphatic alcohols were formed from carbon monoxide and hydrogen, and aliphatic acids from alcohols and carbon monoxide. The high-pressure equipment then designed and constructed has proved a useful asset in the prosecution of the Laboratory's researches, and has frequently been made use of by industrial firms and other organisations. Other subjects under investigation are the production of various useful chemicals by catalytic hydrogenation and amination. A study is also being made of the preparation and polymerization of substances containing silicon. The Organic Intermediates Section also played a useful part in the development of the new synthetic fibre 'Terylene'.

Items of biological or agricultural interest which have been investigated in recent years or are still under investigation include the discovery of one drug of outstanding properties. This substance, 2 : 7-diamino-9-phenyl-10-methyl-phenanthridinium bromide, or C.R.L.1553, has been widely used against nagana, a trypanosome disease of cattle in Africa.

In order to make further use of Colonial products, research was carried out by the Microbiological Group of the Laboratory into the production of food yeast from molasses. Yeast production up to a pilot-plant stage was successfully achieved using a special strain of yeast, and the process is now in the course of full-scale production in Jamaica.

In collaboration with stations of the Agricultural Research Council, effective sheep dips and sprays containing D.D.T. have been formulated against blow-flies and sheep ticks, and special tar-acid emulsions were developed as a substitute for sulphuric acid in the destruction of potato haulm. The future policy of the Laboratory will be to extend these fruitful fields of discovery, to broaden the range of techniques available and to make the work of the Laboratory of the maximum possible value to British industry and to the chemical community as a whole.

NUTRITION IN NEWFOUNDLAND*

A STUDY of the history of Newfoundland should convince even the most hardened opponent of the need for Government planning. This island, a little larger than Ireland, a little smaller than England, has now some 320,000 inhabitants, mostly descendants of the original settlers who came from the British Isles. These settlers established themselves on the basis of one industry—cod-fishing—and sold their dry salt cod in many markets of the world. They bothered little about agriculture, and they soon depleted the stocks of game which once enriched the interior. This dependence on a single 'cash crop' meant that a bad year or a fall in the demand for their product not only spelt economic distress at the time but also resulted in a general downward trend from which the community was unable to extricate itself. In 1934 it was found necessary to suspend Dominion status.

As might be expected, this economic degradation showed in the health of the people : in a high infantile mortality-rate, in the number of still and premature births, in the incidence of tuberculosis, and in various clinical signs of malnutrition, including sporadic outbreaks of dry beriberi. In 1944 it was decided to copy the American plan of 'enriching' white flour with iron and some B-vitamins; but measures far more comprehensive than that are needed if Newfoundland's sickness is to be cured. Fortunately, there are now signs that this fact is recognized.

The nutrition workers who carried out the "Medical Survey of Nutrition in Newfoundland" in August 1944 were not content merely to report their clinical findings, but also submitted to the Commissioner for Public Health and Welfare specific recommendations for dealing with the situation, and they advised the setting up of a Council of Nutrition, "to include senior members representative of all the Departments concerned in the promotion of better nutrition of the people of the country". These recommendations were accepted by the Department of Public Health and Welfare as being "sound and essentially capable of being implemented", and a year later Dr. D. P. Cuthbertson, of the Medical Research Council, visited the island to advise on "the ways and means of approaching the programme in the field".

His report reviews the evidence compiled by the various surveys that had been made and discusses in detail the pros and cons of different methods of implementing the recommendations. The arguments range over such problems as 'enrichment' versus higher extraction rates for flour, 'uneconomic' local milk production versus imported processed milk, etc., and are therefore of interest to other territories besides Newfoundland.

From it all emerges, quite clearly, the fact that this programme for the attainment of good nutrition is going to make demands on agriculture, education, transport, industry and, not least, on the people themselves. Planning and direction are essential for, in Dr. Cuthbertson's own words, "Newfoundland . . . cannot, as at present constituted, exist as a sound economic unit capable of improving its social services so that there is freedom from want and disease". M. W. GRANT

* Report on Nutrition in Newfoundland. By Dr. D. P. Cuthbertson. Pp. 87. (Dominions No. 4.) (London : H.M. Stationery Office, 1947.) 1*s*. 6*d*. net.

QUANTUM ELECTRODYNAMICS

THE subject of quantum electrodynamics is extremely difficult, even for the case of a single electron. The usual method of solving the corresponding wave equation leads to divergent integrals. To avoid these, Prof. P. A. M. Dirac* uses the method of redundant variables. This does not abolish the difficulty, but presents it in a new form, which may be dealt with in two ways. The first of these needs only comparatively simple mathematics and is directly connected with an elegant general scheme, but unfortunately its wave functions apply only to a hypothetical world and so its physical interpretation is indirect. The second way has the advantage of a direct physical interpretation, but the mathematics is so complicated that it has not yet been solved even for what appears to be the simplest possible case. Both methods seem worth further study, failing the discovery of a third which would combine the advantages of both.

There is another fundamental problem in quantum electrodynamics. The classical theory disagrees with experiment, in that it allows a charged particle, in the absence of an ingoing field, to build up an acceleration and to radiate energy. This difficulty can be overcome in the classical theory by imposing the extra condition that the final acceleration must be zero. In quantum electrodynamics, the first of the new methods mentioned above does not seem to need any extra condition. On the other hand, the

* "Developments in Quantum Electrodynamics", Communications of the Dublin Institute for Advanced Studies A3, 1946.

second method does need an extra condition, but it is not at all clear what form it should take.

Theoretical physics is much more complicated than it appeared earlier in this century. About thirty years ago it seemed that all physical quantities were expressible in terms of tensors. The discovery of the wave equation of the spinning electron showed that we needed also spinors. Now Prof. Dirac shows that for quantum electrodynamics we need a new kind of quantity with components which transform linearly under Lorentz transformations, which he calls an 'expansor'. It has an enumerably infinite number of components.

FORTHCOMING EVENTS

Monday, July 28—Saturday, August 2

PHYSICAL SOCIETY, COLOUR GROUP (at Cambridge).—Conference on "Colour Vision".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER (temporary) IN PHILOSOPHY—The Secretary and Registrar, University College of North Wales, Bangor (August 1).

LECTURER IN APPLIED MECHANICS at the Royal Naval College, Greenwich—The Director, Education Department, Admiralty, London, S.W.1 (August 2).

SENIOR LECTURER IN ENGINEERING, and a LECTURER IN ENGINEERING OR ENGINEERING MATHEMATICS—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (August 2).

LECTURER IN ENGINEERING PHYSICS, to work in the Electrical Engineering Department of Queen Mary College and the Electro-Therapeutic Department of the London Hospital Medical College—The Registrar, Queen Mary College, Mile End Road, London, E.1 (August 2).

LECTURER IN ELECTRICAL ENGINEERING, a LECTURER IN AUTOMOBILE ENGINEERING, a LECTURER IN MECHANICAL ENGINEERING SUBJECTS, a WELDING AND SHEET METALWORK INSTRUCTOR, and a LECTURER IN BIOLOGY, at the Blackpool Technical College and School of Art—The Chief Education Officer, Education Offices, 3 Caunce Street, Blackpool (August 2).

ASSISTANT well qualified to teach MECHANICAL AND ELECTRICAL ENGINEERING SUBJECTS, at the Bolton Municipal Technical College—The Chief Education Officer, Education Offices, Nelson Square, Bolton (August 2).

LECTURER IN MECHANICAL ENGINEERING—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (August 2).

LECTURER IN ELECTRICAL ENGINEERING, and a LECTURER IN MECHANICAL ENGINEERING—The Principal, Paisley Technical College, Paisley (August 2).

PRINCIPAL OF THE TECHNICAL COLLEGE shortly to be established in Salisbury—The Director of Education, County Hall, Trowbridge, Wilts, endorsed 'Salisbury Technical College' (August 6).

JUNIOR PHYSICIST for research in connexion with medical applications of artificial radio-elements—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12 (August 7).

LECTURER IN ELECTRICAL ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 3 (August 12).

RESEARCH CHEMIST at the National Gallery, London—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.512.47A (August 12).

SENIOR DIETITIANS and JUNIOR DIETITIANS to the Ministry of Food—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting G.248.47A (August 14).

JUNIOR PROFESSIONAL OFFICER (woman) IN THE BRANCH OF BOTANY AND PLANT PATHOLOGY, Department of Agriculture, Southern Rhodesia—The Official Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (August 15).

REGISTRAR OF RHODES UNIVERSITY COLLEGE, Grahamstown—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, London, W.C.2 (August 15).

ASSISTANT VETERINARY INVESTIGATION OFFICER—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (August 15).

ASSISTANT PHYSICIST—The Secretary, University College Hospital, Gower Street, London, W.C.1 (August 15).

LECTURER IN PHARMACOLOGY—The Dean, Guy's Hospital Medical School, London, S.E.1 (August 15).

ASSISTANT (able to undertake instruction in Mathematics) IN THE DEPARTMENT OF MECHANICAL ENGINEERING, and an ASSISTANT (able to undertake instruction in Chemistry) IN THE DEPARTMENT OF GEOLOGY—The Secretary, School of Mines, Camborne (August 23).

ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Cathays Park, Cardiff (August 23).

LECTURER (Grade IIc) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (August 25).

LECTURER IN MEDICINE—The Secretary, The University, Edmund Street, Birmingham 3 (August 31).

SENIOR SCIENTIFIC OFFICER in the Food Investigation organisation of the Department of Scientific and Industrial Research for work in a small laboratory at Smithfield, London, in association with the Low Temperature Research Station, Cambridge—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1943 (September 1).

SENIOR LECTURER IN GEOLOGY at the Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 1).

LECTURER IN GEOGRAPHY—The Secretary, Queen's University, Belfast (September 7).

CHAIR OF CIVIL ENGINEERING at the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 12).

PROFESSOR OF FINE ART (and Director of the Michaelis School of Fine Art); SENIOR LECTURERS IN (*a*) ZOOLOGY, (*b*) COMMERCE; LECTURERS IN (*a*) GEOGRAPHY (2), (*b*) PHYSICS, (*c*) PURE MATHEMATICS (2), (*d*) FRENCH; SUPERVISOR OF FIELD WORK (Social Science), in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 15).

SENIOR RESEARCH FELLOW IN THE DEPARTMENT OF CHEMISTRY, University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Melbourne, September 30).

SENIOR LECTURER IN MEDIÆVAL PHILOSOPHY—The Secretary of Faculties, University Registry, Oxford (October 1).

EXPERT IN TOBACCO GROWING (M.N.18166), AGRICULTURAL INSTRUCTOR IN TOBACCO GROWING (M.N.18167), for the tobacco monopoly of the Government of Iraq; TOBACCO BREEDING SPECIALIST (M.N. 18181), for the Directorate General of Agriculture, Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting appropriate Ref. No.

MECHANIC for experimental laboratory workshop in DEPARTMENT OF BIOCHEMISTRY, a TECHNICIAN IN THE DEPARTMENT OF ZOOLOGY, and a TECHNICIAN IN THE DEPARTMENT OF PHARMACOLOGY—The Establishment Officer, University College London, Gower Street, London, W.C.1.

ASSISTANT LECTURER IN GEOGRAPHY—The Secretary, Queen's University, Belfast.

HEAD OF THE PHYSICS DEPARTMENT—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan.

EXPERTS IN AGRONOMY (M.N.18175), PLANT PATHOLOGY (M.N. 18176), PLANT NUTRITION AND FERTILIZERS (M.N.18182), COTTON BREEDING (M.N.18177), SHEEP BREEDING (M.N.18178), FORAGE CROPS (M.N.18185), BIOMETRY (M.N.18186), PLANT BREEDING (M.N.18187), AGRICULTURAL EXTENSION AND DEMONSTRATION WORK (M.N.18179), for the Directorate General of Agriculture, Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting appropriate Ref. No.

LECTURER IN CHEMICAL ENGINEERING—The Head of the Department of Chemical Engineering and Applied Physical Chemistry, Imperial College of Science and Technology, South Kensington, London, S.W.7.

UNIVERSITY ASSISTANTSHIP IN THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, The University, Edinburgh.

LECTURER IN BIOLOGY—The Registrar, Municipal College, Portsmouth.

ASSISTANT ENGINEER or TECHNICIAN FOR X-RAY DEPARTMENT, and a SENIOR ASSISTANT PHYSICIST—The Secretary, Mount Vernon Hospital and the Radium Institute, Northwood, Middx.

RESEARCH STATISTICIAN, an ASSISTANT STATISTICIAN, and a MATHEMATICAL COMPUTER—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

CHEMISTS IN THE JOINT DEPARTMENT OF CHEMISTRY, Malayan Union and Singapore—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

LECTURER IN ELECTRICAL ENGINEERING—The Clerk to the Governors, Heaton Technical Institute, 12 Chapel Street, Marlpool, Heanor, Nottingham.

LECTURER IN MINING at the Cannock Chase Mining College—The Director of Education (Dept. F.E.), County Education Offices, Stafford.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 72: Modern Views on the Chemistry of Vulcanization Changes, Part 1, Nature of the Reaction between Sulfur and Olefins, by E. Harold Farmer and F. W. Shipley; Part 2, Role of Hydrogen Sulfide, by Ralph F. Naylor; Part 3, Reaction of Sulfur with Squalene and with Rubber, by George F. Bloomfield. Pp. 26. Publication No. 73: A Simple Laboratory Falling-Film Molecular Still. By E. Harold Farmer and D. A. Sutton. Pp. 4. Publication No. 74: Kinetic Studies in the Chemistry of Rubber and Related Materials, 2, The Kinetics of Oxidation of Unconjugated Olefins; 3, Thermochemistry and Mechanisms of Olefin Oxidation, by J. L. Bolland and Geoffrey Gee. Pp. 18. (London: British Rubber Producers' Research Association, 1946.) [301

British Electrical and Allied Industries Research Association. Twenty-sixth Annual Report, October 1, 1945, to September 30, 1946. Pp. 148. (London: British Electrical and Allied Industries Research Association, 1947.) [32

Other Countries

Smithsonian Miscellaneous Collections. Vol. 106, No. 16: New Birds from Colombia. By Alexander Wetmore. (Publication 3862.) Pp. ii + 14. Vol. 106, No. 17: Some New Cambrian Bellerophont Gastropods. By J. Brookes Knight. (Publication 3865.) Pp. ii + 11 + 2 plates. (Washington, D.C.: Smithsonian Institution, 1946–1947.) [291

Classified List of Smithsonian Publications available for Distribution, December 1, 1946. Compiled by Helen Monroe. (Publication 3858.) Pp. iv + 53. (Washington, D.C.: Smithsonian Institution, 1946.) [291

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TRAINING OF SOCIAL WORKERS

NOTWITHSTANDING the fact that many social workers have succeeded without taking a course in social studies at a university, it is an outstanding feature of training for social work in Great Britain that it has been developed largely as a branch of university education. Partly because this incorporation in, or connexion with, a university distinguishes British training schemes from those in most European countries (where special schools for the training of social workers have been established), and to a lesser degree from those in the United States (where independent 'trade schools' and schools affiliated to a university exist side-by-side), it is too often forgotten that those university courses which are to-day designed to provide a theoretical basis for a social worker's practical work had their origins outside the universities. Soon after its foundation in 1869, the Charity Organisation Society organised for its workers courses enabling them to train as almoners; and, so long ago as 1893, the Women's University Settlement in Southwark initiated courses of lectures for social workers.

When the courses arranged at the Women's University Settlement led directly to the foundation of the School of Sociology—which became in 1913 the Social Science Department of the London School of Economics—the question of the relation between theory and practice was immediately raised. In the report of the proceedings of a conference convened in 1902 to discuss the creation of the School of Sociology, it is recorded that there was a wholesome prejudice against mixing theoretical and practical training. It was, the report continues, regarded as "imperative that the teaching of the Universities should be free from any suspicion of bias in controversial matters. Their function was to train students in the observation of facts and the construction of theory from such observation. . . . It would be improper for the University to attempt to direct studies in their practical work, but it might be done in University Extension lectures and by lecturers specially qualified going from place to place."

As long as the number of social workers remained small and their activities circumscribed, the integration of theoretical and practical training remained a secondary issue. With the recent increase in the number of social workers and the extension of their activities, the profession has, in the opinion of Miss Eileen L. Younghusband, "reached the point of development when neither general social science courses nor purely professional training fully meets its needs"; and her "Report on the Employment and Training of Social Workers"* is a plea for experiment in improving the quality of training. The weaknesses of present methods are all too obvious. Although university courses are generally of a high academic standard, they are unquestionably weak on the practical side; and much professional training—which might, if properly orientated, make good this deficiency—is so weighted as to make no significant contribution to the general body of knowledge and adds little to the student's education in basic principles.

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* Carnegie United Kingdom Trust, Comely Park House, Dunfermline, Fife.

Although it certainly cannot be justified, the inadequacy of the part which is being played by many of the practical agencies engaged in training students can, in present circumstances, be explained. That those who carry out the day-to-day supervision of a student's work may themselves be trained or untrained may, or may not, be significant. What undoubtedly is significant is that they are not usually chosen because of some special aptitude for teaching students, that they have not normally been trained in teaching methods, and that they are compelled to regard the training of students as an incidental activity in the day's routine. It is therefore not surprising that Miss Younghusband finds "too little emphasis on the ethical and sociological issues involved in social work and on methods of helping people to help themselves. . . . Students are too often accepted because they are useful to the agency and not in order that a planned contribution may be made to the education of future social workers." It is, however, good to know that this critical attitude towards existing training schemes is shared by many social workers who are displaying "a tendency to stand back and look objectively at methods and a desire to seek guidance from their own best members and from outsiders in thinking out what they are trying to achieve".

That this discontent has not resulted in a spontaneous demand for the closer integration of theory and practice in university courses Miss Younghusband attributes to the clash of ideas which still exists regarding the function of a university and which was summarized so recently as 1944 in the two points of view expressed in the report of the McNair Committee on "Teachers and Youth Leaders". Those who favoured the joint board scheme declared: "If we may venture on a few general observations upon the functions of the Universities, we may say that in our opinion their main duty consists, and properly consists, in teaching basic subjects and in the advancement of knowledge". Opposed to them were the supporters of university schools of education who dissented strongly "from any sharp distinction between education and training, as though the one were the proper concern of the best institutions and teachers and the other were not". Rather did they express themselves as being concerned with training as "that part of the education of a student which emphasizes that he is preparing himself for a practical profession".

Nevertheless, as Miss Younghusband is well aware, the clash is academic rather than real. In providing courses for teachers and medical men the universities have long accepted the fact that they undertake vocational training. Where, perhaps, they have not accepted the responsibility thus incurred as fully as they might is in not always acknowledging the further fact that, having established such courses of training, they are logically committed to "testing the general suitability of those whom they admit, and whom they permit to complete the course and to emerge hall-marked with a professional qualification". Not the least of the merits of both the McNair and Goodenough Reports is their insistence on this point. As regards teachers, the former says that practical training in schools "should be so arranged that it enables a training institution to discover any students who are so clearly unsuited for teaching that they should be advised and, if necessary, required to abandon preparation for the profession"; and the latter, commenting on the selection of medical students, categorically insists that "however well-designed and conducted the training may be, it cannot produce successful results unless (1) in its organisation and conduct it allows for the full and active participation of the students, so that their education proceeds as much by their own efforts to learn as by their teachers' efforts to instil knowledge into them, and (2) the students are of suitable character and temperament and of an adequate standard of mental and physical fitness". Although Miss Younghusband quotes the passage from the McNair Report which postulates that "the personal suitability of applicants for entry into youth service is fundamental, and the institutions offering courses of training will keep continuously before them the need for devising the proper machinery of selection", she resists the easy—and obvious—conclusion that the quality of the training of social workers can be raised *merely* by increasing the vocational responsibility of the universities.

In this she is undoubtedly right. One result of the long separation—or, at best, partial integration—of theoretical and practical training is that the complexity of the problem has increased. There is, for example, no body of literature about the variety of human problems which make up the case or group worker's field of operation. Although, as she shrewdly remarks, it "could be continued indefinitely", Miss Younghusband's list illustrative of the need is in itself formidable: the highly sexed adolescent girl, the 'problem family', foster-home placement and adoption, 'unclubables', and the psychological factors involved in creating a community centre. Again, because it would be foolish to suppose that the closer integration of existing theory and practice would solve all training problems, there is the need for systematic inquiry and experiment. No attempt has yet been made to analyse the total content at which training courses should aim. Nor has it been decided what can most appropriately be acquired by lectures or discussion groups associated with lecture courses, or by working through illustrative cases, or by reading, work diaries kept by students, demonstrations, social surveys, visits of observation and actual practical work in different agencies. Miss Younghusband, who can speak with authority regarding the usefulness of the 'piecemeal and spasmodic' studies which are being undertaken, is emphatic that, if social work is to make any significant advance, a scheme designed both to promote research and to stimulate training must immediately be launched. Nor is she less emphatic that, as neither research will be promoted nor training stimulated "unless they are planned in relation to each other, and unless they are generously financed over a period of years until they are so well established as to be able to stand on their own feet", nothing less will suffice than the creation of a school of social work.

Few, if any, would dissent from the view that such a pioneer institution "could do far more to raise the whole standard of training than some relatively slight improvement in methods in the various social science departments". Nor will there be many to dispute that a school of social work should be designed for four purposes: (1) to undertake research; (2) to run courses in the theory and practice of social work, leading to a post-graduate diploma, for suitable graduate and other students; (3) to provide general and refresher courses for social workers, teachers, Civil servants and others whose profession requires a knowledge of social conditions; and (4) to provide facilities for study for social workers from other countries. More controversial, however, are some of the detailed proposals. Should the school be a separate school of a university, analogous to the Institute of Education in the University of London? Can the purposes of such a school be met by courses extending over a period of fifteen months? Should the number of students be limited to not more than a hundred? Should part-time and evening courses be made available?

In formulating her own ideas on these and other questions, and incorporating them in the report as a basis for further discussion, Miss Younghusband has performed a useful service. Unanswerable as her arguments in favour of the creation of a school of social work would seem to be, the immediate implementation of such a scheme is clearly impossible. As Mr. E. Salter Davies says in a foreword which he contributes to the report, so large a project is outside the competence of the Carnegie Trustees during the current quinquennium. Nevertheless, it has not been placed on one side. The examination of the practical possibilities of the scheme has already been entrusted to a committee composed partly of members of the Carnegie Trust and partly of persons actively engaged in social work. This is a step on which the Carnegie Trustees are deservedly to be congratulated; and it may confidently be predicted that, whatever this committee may recommend as the first practical step, the publication of this challenging and scholarly report will mark the end of an era in which the term 'social work' has been used much too loosely.

THE UNION OF MATHEMATICS AND PHYSICS

Methods of Mathematical Physics

By Dr. Harold Jeffreys and Dr. Bertha Swirles Jeffreys. Pp. ix+679. (Cambridge: At the University Press, 1946.) 63*s*. net.

A CENTURY ago or more, the study of astronomy, mechanics and physics was one of the most potent factors in the origination and development of new branches of pure mathematics. Men like Euler, Cauchy, Hamilton and Gauss were keenly interested both in natural philosophy and pure mathematics, and there was often a fruitful inter-connexion between the two parts of their work. With increasing specialization, the exponents of the two sciences tended to drift apart, and relatively few continued to cultivate both. The pure mathematicians went forward into regions whither few physicists of the time were able to follow them, and indeed most physicists regarded any such attempt as futile for their purposes.

The physicists, moreover, found an immense amount of valuable and interesting pioneer and development work in their laboratories, requiring little mathematical knowledge and skill. Even on the theoretical side, much of their work consisted of hypotheses of limited range, requiring only elementary mathematical development. A few men of exceptional insight, like Riemann, Maxwell, Boltzmann and, later, Einstein, were not content with this piecemeal science, and sought a wider synthesis. Maxwell ("Coll. Works", vol. 2, p. 419), criticizing the procedure current in the theoretical physics and chemistry of his time, wrote thus:

"In attempting . . . the explanation of chemical phenomena, we have to form an idea of the configuration and motion of a number of material systems, each of which is so small that it cannot be directly observed. We have, in fact, to determine, from the observed external actions of an unseen piece of machinery, its internal construction.

"The method which has been for the most part employed in conducting such enquiries is that of forming an hypothesis, and calculating what would happen if the hypothesis were true. If these results agree with the actual phenomena, the hypothesis is said to be verified, so long, at least, as some one else does not invent another hypothesis which agrees still better with the phenomena.

"The reason why so many of our physical theories have been built up by the method of hypotheses is that the speculators have not been provided with methods and terms sufficiently general to express the results of their induction in its early stages. They were thus compelled either to leave their ideas vague and therefore useless, or to present them in a form the details of which could be supplied only by the illegitimate use of the imagination."

Maxwell went on to indicate where and how a better way was to be found. "In the meantime the mathematicians, guided by that instinct which teaches them to store up for others the irrepressible secretions of their own minds, had developed with the utmost generality. . . ." His particular reference was to the general theory of dynamics, developed by Lagrange, Hamilton, Jacobi and others, which in our time has proved marvellously apt as a basis on which to build the new edifice of quantum mechanics. In the same way, the recondite geometrical and analytical researches of Riemann, Christoffel and others (in their day "to the [applied mathematicians] a stumbling block and to the [physicists] foolishness", to vary St. Paul's words) provided the tool needed by Einstein in developing his theory of general relativity and gravitation.

In this and other instances the history of modern physics confirms Maxwell's views. Great as are the achievements possible to the non-mathematical experimenter gifted with genius, the development of a true natural philosophy, a wide-embracing synthesis, requires the union of great mathematics with great physics.

To check the diverging drift of physics and mathematics into realms with different languages and interests, and to aid the physicists who realize the need for a combination of both, Courant and Hilbert as mathematicians produced in 1924 the first part of their famous work "Methoden der mathematischen Physik"; Part 2 followed in 1937, and together they form a great compendium and exposition of well-chosen domains of pure mathematics, valuable and relevant to physics.

Their example has now been followed by another such synthesis, worthy to bear comparison with that great predecessor—a British work, by two authors who are doing research and teaching mathematics in the University of Cambridge, and published in attractive form by its Press. Though consisting of one volume only, of manageable size, its content is about a third larger than that of Courant and Hilbert, with a word space of about 450,000 as against 350,000, though, of course, in each case much of this space is taken up by displayed formulæ.

A detailed comparison of the two books would be of great interest but cannot be undertaken here. Naturally, a good deal of ground is common to the two works; but there are also great differences of treatment and choice of material. In both works (and more particularly in the German one) the index is inferior in execution to the body of the work, and somewhat more effort spent upon it would have much helped the reader. But a comparison of the authors' names cited in the two indexes shows that the possession of Courant and Hilbert by no means renders superfluous that of '$2J$'—if one may modify and adapt, for the sake of a short and euphonious name of this book by Prof. and Mrs. Jeffreys, the familiar nomenclature (W^2) used by many mathematicians for "Modern Analysis" by Profs. Whittaker and Watson. It is safe to predict that '$2J$' will stand alongside 'W^2' as a treasured possession on the shelves of many physicists.

Among the distinctive and attractive features of '$2J$' are the initial chapters on the real variable, and Chapter 9 on numerical methods. Prof. Jeffreys' earlier monographs on operational methods and on Cartesian tensors are incorporated in other chapters. As in his volume "The Earth", the chapters are headed by quotations, the aptness of which is apparent in many cases. The chapters end, not, as in Courant and Hilbert, with references to further literature, but, in English fashion, with examples on which the reader can test his skill and his mastery of the text.

The book is well written, and the 'joins', if any, between the work of the two authors have not been detected by the reviewer. The severity of the subject-matter is occasionally lightened by touches showing the personality of the expositor. The book is a worthy addition to the great series of 'Cambridge Blues'.

FOLKLORE ON THE FARM

The Farmer's Friend or Wise Saws and Modern Instances

Being a Collection of Country Sayings. Compiled and commented upon by W. S. Mansfield. Pp. xiii+107. (Cambridge: At the University Press, 1947.) 6*s*. net.

PROVERBS, saws and trite sayings entered very largely into the conversation of countryfolk of old. In old-time Somerset, a couple of knowing heads would often wag over the stile, and two pairs of wise old eyes would peer through the lofty hedges at the snowy masses of fragrant apple-blooth, flushed with a faint pink Alpine glow. "A good cider year, please God!" "Please God!" comes the echo. "Thof a proud spring 'd' often get his comb cut!"

Mr. Mansfield's collection of sayings, most of which he has gathered directly from farmers, has been produced in an attractive format, with four charming and appropriate illustrations by John Hookham. In the first place we may comment on the numerous references to seasons of the year and even to characteristics of particular months. In the present age, when the bulk of our population no longer lives in close touch with Nature, many of these sayings will appear cryptic; but here Mr. Mansfield steps in with crisp explanations that cast light on the most recondite statements. For example, "If you see grass in January, Lock your grain in your granuary"; because premature growth is usually cut back by the return of cold weather. Again, "What grows in May should be eaten in May"; because the young and leafy May grass, with its high nutritive value, if under-grazed, will become woody and indigestible in June. Some of the older sayings of the months, no longer current, might be harder to interpret, as they often contain obsolete words. Thus, John Aubrey, the seventeenth-century antiquary, mentions a Wiltshire saying, "Sowlegrove sil lew" (February is seldom mild). "The vulgar in the West of England," he says, "doe call the moneth of March, *Lide*"—a word we find in the old rhyme: "Eate leeks in Lide, and ramsins in May, And all the year after physicians may play".

These obsolete words show the great age of some of the sayings, and illustrate the faithfulness of oral tradition among the English peasantry. Mr. Mansfield quotes, "An eldern stake and whitethorn ether, Will make a hedge to last for ever". Here, in 'ether' or 'edder', we have a word going back to the days of King Alfred: it refers to the twisted wands of a laid (or 'plushed') hedge. Eldern stakes, it used to be said in the West Country, will outlast in the ground an iron bar of the same size. Another western adage embalming a close knowledge of the characteristics of trees tells us that "A withy tree will buy a horse before an oak will buy a bridle and saddle": the willow is noteworthy for rapid growth.

In a short introduction of much charm, Mr. Kendon points out that modern agricultural research does not always bear out the truth of the adage; but more often than not these old sayings, preserving the accumulated experience of generations, are fundamentally sound. "Copper under heather, silver under gorse, gold under bracken": Mr. Mansfield shows that the experience of War Agricultural Committees has amply confirmed the truth of this picturesque saying. One must confess, however, that upon occasion there is an ambivalent quality in some of these expressions. Thus, "The master's foot is the best manure" inculcates the need for incessant watchfulness and industry on the land; but on the other hand, Jan Ridd tells us in "Lorna Doone" that—leastways, in Somerset and Devon—"God makes the wheat grow greener, While farmer be at his dinner".

A characteristic epitome of rural wit and wisdom is to be found in one of Mr. Mansfield's items which says that "He that buys land buys many stones, He that buys flesh buys many bones; He that buys eggs buys many shells, He that buys good ale buys nothing else". It is perhaps scarcely in keeping with old-time rustic thought to suppose, however, that the last sentence casts any reproach at the ale-bibber. The meaning seems rather to be that he who buys ale pays for no waste material, except perhaps for the last few drops in the cup which he sprinkles on the ground as a libation to a long-forgotten pagan deity commemorated in the traditional expression, "A drop for the wold Heark !"

Such sayings as we find in this intriguing collection range over the whole gamut of rural experience, and are by no means confined to observations on seasons, weather, birds, beasts, crops, trees, and the like. The human element, for example, is evident in such sayings as, "One boy is a boy, two boys are half a boy, and three boys are no boy at all"—a profound truth which holds in the laboratory as fully as in the field. Perhaps latter-day conditions will give rise to a similar saying in which the one, two and three boys are replaced by Greenwich time, summer time, and double summer time !

One final example, drawn from the reviewer's own experience, may be given as a masterpiece of terse expression. A Somerset farmer of the old school had been listening silently to a discussion on strikes and strikers. His opinion was asked. He removed his pipe, and as the adjacent cider-cup rose to its appointed place he let fall the memorable judgment : "Ah . . . Laziness idden wo'th much 'ithout 'tis well vollied !" JOHN READ

SCIENCE AND LIFE IN THE WORLD

Science and Life in the World

The George Westinghouse Centennial Forum, May 16, 17 and 18, 1946. (Whittlesey House Publication.) Vol. 1 : Science and Civilization ; The Future of Atomic Energy. Pp. ix+152. 12*s*. 6*d*. Vol. 2 : Transportation—a Measurement of Civilization ; Light, Life and Man. Pp. ix+236. 12*s*. 6*d*. Vol. 3 : A Challenge to the World. Pp. ix+198. 12*s*. 6*d*. (New York and London : McGraw-Hill Book Co., Inc., 1946.)

ON May 16, 17 and 18 of last year a significant gathering of men of science and leaders in the worlds of education and industry met at Pittsburgh to commemorate the hundredth anniversary of the birth of George Westinghouse, one of America's most renowned inventors and industrialists. Twenty-four prominent men in the field of science and technology were invited to participate in a notable symposium which summarized a great deal of our current scientific knowledge and pointed the way towards future research and development. A verbatim transcription of the addresses given on this occasion, together with illustrations including photographs of all the speakers, have been collected to make the three volumes reviewed here. As is to be expected, there is a wide variety of style, treatment and informative content in the different discourses.

The proceedings of the first day opened with an address on scientific ethics by Prof. A. V. Hill, foreign secretary of the Royal Society, who provided the link between the diverse matters which were considered after this. His thesis was that "the conditions of survival of man as a biological species and of his civilization involve a totally new factor in biology, the use of organised reason and accumulated knowledge. It was that which made the various civilizations possible and its perversions helped at intervals to bring them to an end." He is followed by Dr. Isaiah Bowman, the president of Johns Hopkins University, who speaks on the social composition of scientific power, and together with Dr. V. Bush, whose subject is "Planning in Science", provides a useful outline of the social aspects and possibilities of science. The latter part of the first volume is devoted to atomic energy.

Prof. J. R. Oppenheimer, who was in charge of the Los Alamos laboratory where the first atomic bombs were made, is rather inhibited by the demands of security, though he has some useful things to say and speaks with authority ; whereas Prof. E. Fermi, who constructed the first atomic pile, is less restrained and gives an account of the development of the pile, of which those at Hanford produce energy in amounts comparable with that of the largest hydro-electric plants. The applications of the new atomic discoveries to biology and medicine are dealt with by Dr. E. Chamberlain ; and Dr. Hugh S. Taylor of Princeton, who is perhaps best known in Britain for his catalytic phase-change method of separating heavy water, gives a short and simple statement of nuclear science in chemistry.

The first part of the second volume is concerned with the problems of transport, particularly from the American point of view. The scientific organisation of shipping, aviation and road transport is considered by various American experts in terms of economics, speed and convenience. The chapters should prove to be valuable to those who have to cope with the differing conditions in Great Britain and Europe ; but of most interest to the sociologist and layman is C. F. Kettering's paper on "The New American Way of Life" due to the development and popularization of the automobile. The book concludes with an excellent section entitled "Light, Life and Man". The various papers deal with biological warfare, photosynthesis, genetics with particular reference to artificial mutants and the recent work on moulds and enzymes, and Dr. Linus Pauling's investigations on molecular architecture in relation to biological reactions.

The third volume is an interesting mixture which shifts kaleidoscopically from one topic to another. There is a verbatim report of a broadcast brains trust, "Science, Salvation or Destroyer of Mankind", in which Dr. Urey has much to say. Also, we find an illustrated 'conducted tour' of the Buhl Planetarium and Institute of Popular Science at Pittsburgh. Accounts are also given of demonstrations in microbiology and crystallography using the optical apparatus at the same institution. There can be no doubt that good optical aids are an asset to the effective teaching of 'background' science. There follows a description of a visit to the Mellon Institute with its research work in plastics, petroleum and metallurgy. The volume also includes a number of short papers on the future of science as an aid to mankind, and Karl Compton's address on science "as an assurance against aggression and depression". The book ends fittingly with a short biography of George Westinghouse (1846–1914) by L. M. Stark. A detailed account is given of his invention of the air brake and the development of the turbo-alternator in the United States.

It is to be hoped that many more symposia on the broader social and ethical aspects of science will be held in various parts of the world, and that they will be reported as effectively as is done in these three admirably produced books. W. L. SUMNER

Calculating Machines

Recent and Prospective Developments and their Impact on Mathematical Physics; Inaugural Lecture. By Prof. D. R. Hartree. Pp. 40 + 2 plates. (Cambridge: At the University Press, 1947.) 2*s.* net.

THE rapid development of large-scale, high-speed calculating machines which has taken place in the United States in recent years is still not fully appreciated in Great Britain. These machines, in one form or another, are embodiments of Babbage's idea of an "analytical engine", and will undoubtedly have important effects both on numerical methods and on the attitude of the mathematical physicist to his problems. There is as yet no machine of this kind in Britain, though one is being planned at the National Physical Laboratory. The number of people from Great Britain who have seen the American machines is less than a dozen, and of these only one, Prof. D. R. Hartree, has actually worked the E.N.I.A.C., the electronic machine constructed at the University of Pennsylvania. This little book, therefore, has a particular importance. In this reprint of his inaugural lecture Prof. Hartree describes the E.N.I.A.C., and gives an account of the use he made of it in the solution of a set of non-linear differential equations with a two-point boundary problem. This gives him an opportunity to demonstrate vividly the remarkable speed of this type of machine, and to consider what features are desirable in such machines for general use in the field of mathematical physics.

The final section discusses the impact of these new developments on mathematical physics. The author suggests that not only will new mathematical developments be needed to devise new computing methods, but also that a new attitude to the problems of mathematical physics will be needed to make the best use of the facilities offered by this new type of equipment. In the author's own words, "It seems then quite possible that the facilities offered by these new calculating machines will at least make the formulation of physical problems in terms of integral equations and variation equations more familiar, and may in time wean us from our present tendency to regard a differential equation as the basic way of formulating the mathematics of physical problems".

Chemistry for our Times

By Elbert Cook Weaver and Dr. Laurence Standley Foster. Pp. xii+738. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 12*s.* 6*d.*

THE authors of this new elementary text-book aim at relating chemistry to everyday life, beginning with the immediate environment of the pupil and progressing from more to less familiar experiences. The basis is experimental, although modern theories, including very recent advances, receive adequate attention in their proper places. A special feature of the book is the wealth of illustration, all kinds of industrial plants being shown, as well as striking diagrams and very neat perspective drawings of apparatus. The text is well thought out, suitable revision being introduced from time to time, and the style is clear and attractive. Some organic chemistry is included. Problems are postponed until late, and the questions at the ends of the sections are aimed at stimulating thought rather than being tests of memory. Many anecdotes of the personalities of great discoverers are given, and the international character of science is well emphasized.

Although the book is elementary it is by no means superficial, a large amount of sound information being given in an interesting way; and care has been taken throughout to make the text intelligible and clear to any reader. We think any boy or girl beginning the study of chemistry would be interested by this book, and it could very usefully find a place in any school or public library. The authors are to be congratulated on the result of what must have been a difficult piece of work. There are very few matters which should be altered in future editions, but among these it may be suggested that the information about the explosive properties of mixtures of hydrogen and air should come before, rather than after, the description of experiments with this gas; the date of Black's discovery of fixed air is twice given as 1775 instead of 1756; and the god Aeschylus in Fig. 21–21 should surely be Aesculapius. The very moderate price of the book is most commendable. This is an excellent elementary text-book which brings the modern developments in discovery into relation with classical material in a very skilful way.

X-Rays in Research and Industry

By Dr. H. Hirst. Second edition. Pp. vii+124. (London: Chapman and Hall, Ltd., 1946.) 13*s.* 6*d.* net.

EXCEPT for minor corrections, this book is identical with the first edition published in Australia and reviewed in these columns a few years ago. The book provides a concise introduction to the technique of X-ray diffraction and radiography, and to its applications particularly in physical metallurgy. An outstanding feature is the detail with which the author describes the practical details required by the experimenter, and it is to the practically minded reader that the book will most appeal. Every technique is not covered; but sufficient of the standard techniques is given to allow any worker entering this field to make a useful beginning. Since the first edition, other books have appeared which treat the same field of X-rays and metallurgy in a much more comprehensive manner. The present book will be found helpful, however, as a very readable and succinct introduction to these larger treatises.

W. A. WOOD

Psycho-Analysis and its Derivatives

By Dr. H. Crichton-Miller. (Home University Library of Modern Knowledge, No. 164.) Second Edition. Pp. 272. (London, New York and Toronto: Oxford University Press, 1945.) 3*s.* 6*d.* net.

THIS small book, which has deservedly been a very popular one, gives a strong, straightforward and simple account of the theories of the different schools of psycho-analysis. The three chief schools of Freud, Jung and Adler are all discussed in detail, and Prinzhorn added to them. The writer considers Freud's the most intricate, Jung's the most profound, Adler's the most practical and Prinzhorn's the broadest. Adler's system, of course, owing to its simplicity, attracts a great deal of attention, possibly owing to the appeal of the so-called 'inferiority complex' and of the fact that Adler pays little attention to dreams. Prinzhorn's use of lay analysts almost without limit to their activities is open to criticism, but may, because of this, appeal to a large number of people. There is a brief note on developments along various lines, and some account of Stekel's work published in 1940.

ASPECTS OF THE BIOLOGICAL FUNCTION OF PHOSPHATE IN ENZYMATIC SYNTHESES*

By Dr. HERMAN M. KALCKAR

Department of Medical Physiology, University of Copenhagen

IT is just forty years ago since the late Sir Arthur Harden, together with Dr. W. J. Young, published the significant results of their studies of the effect of inorganic orthophosphate on cell-free sugar fermentation. Harden and Young[1] showed that phosphate is an essential component of this system, and this not merely by acting as a catalyst. They succeeded in showing that phosphate participates as a reactant in the process, that is, it is being esterified to sugar. One mole phosphate is esterified per mole glucose converted into alcohol and carbon dioxide. The phosphoric ester which accumulates was already identified by Harden and Young as fructose-1-6-diphosphate, later called the 'Harden–Young ester'. The chemical events taking place were summarized by Harden and Young in the following equation :

$$2 \text{ glucose} + 2 \text{ phosphate} = 1 \text{ hexosediphosphate} + 2 \text{ ethyl alcohol} + 2 \text{ carbon dioxide.}$$

Harden and Young's fundamental discoveries led to many other important studies such as Robison's and Embden's isolation of glucose monophosphates, Meyerhof and Lohmann's studies of glycolysis in muscle extracts and Lundsgaard's observations of the chemical events which accompany the alactacid muscle contraction.

These developments are familiar to investigators and students in this field. The purpose of the present survey is not to attempt a description of the historical development but rather to try to outline a picture of the present position in this field.

The problems to be discussed have been arranged in the following order :

(1) Generation of phosphate bond energy :

(*a*) from oxidation-reductions (formation of acylphosphates) ;

(*b*) from enol formation from dihydroxy structures (phosphopyruvate).

(2) Transfer of phosphate bond energy :

(*a*) reversible phosphate exchange (adenosine triphosphate-creatine-carboxyl) ;

(*b*) dephosphorylations (myosin adenosine triphosphatase) ;

(*c*) irreversible transphosphorylations (phosphorylation of hydroxy groups).

(3) Enzymatic exchange of aldehydephosphates with sugars and N-bases :

(*a*) polysaccharide formation (starch and glycogen from glucose-1-phosphate) ;

(*b*) dissaccharide formation (from glucose-1-phosphate) ;

(*c*) nucleoside formation (from ribose-1-phosphate and P-nucleic acid).

Such an arrangement is, of course, purely arbitrary, but it is hoped that it will facilitate the presentation of the problems to be discussed.

It is logical, for example, to start the discussion with a description of the characteristics of biological oxidation-reductions which, being reactions capable of releasing large amounts of energy, condition the occurrence of biological syntheses.

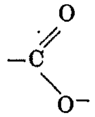
The first oxidation step in the breakdown of sugar is the oxidation of phosphotriose to phosphoglyceric acid, which is eventually converted into pyruvic acid. In fermentation, the latter is either reduced directly to lactic acid, which is the typical glycolysis, or reduced after decarboxylation, which is alcoholic fermentation. The conversion of phosphotriose to pyruvate involves two reactions which produce much energy. The first and most important of these steps is the oxidation of phosphoaldotriose to phosphoglyceric acid, the cozymase being the electron acceptor. The other reaction is the anhydride reaction by which the α-keto structure of pyruvic acid is formed from the dihydroxy structure of phosphoglyceric acid.

Phosphoglyceric acid, although poorer in energy than phosphotriose, is apparently endowed with an extra source of readily mobilized energy, namely, the possibility of converting the dihydroxy structure of this compound into the anhydride, pyruvic acid. Both the oxidation-reduction and the anhydride reaction are known to be coupled with the synthesis of the energy-rich phosphate bonds[2].

The oxidation of aldehydes to acids has hitherto been described according to Wieland's equation :

$$\text{aldehyde hydrate} \rightarrow \text{carboxylate} + 3H^+ + 2\varepsilon.$$

The release of free energy in this reaction is considerable, due to the formation of the highly stable carboxylate ion :



If one calculates the ΔF of the reaction aldotriose → glycerate, one finds that at pH 7 as much as 29,000 cal. are liberated per mole oxidized.

Calculation of ΔF of other aldehyde oxidations seems to give figures of the same order of magnitude, namely, between 28,000 and 30,000 cal. liberated per mole. This actually is a very large release of energy for a biological step-oxidation. The oxidation of lactate to pyruvate or of alcohol to aldehyde yields only some 8,000–9,000 cal. for example. It is natural to ask whether there is a pathway available to the living organism by which all the energy generated in aldehyde oxidations can be directed into something useful. At least two ways are known. One way, which is universally used, is through oxidation-reduction, that is, the energy of an oxidation is utilized to reduce something else ; this type of energetic coupling occurs in glycolysis.

In glycolysis, aldotriose plays the function of a hydrogen and electron donor, and pyruvate (the α-keto group) as hydrogen and electron acceptor forming lactate. Since the oxidation of lactate to pyruvate at pH 7 yields 8,300 cal., the same amount of energy is required in order to reduce pyruvate to lactate.

The oxidation reduction in glycolysis is not a one-step but a two-step reaction. The electrons from the triose are first transferred to cozymase, a substance which was also described first by Harden and Young in 1906. The chemical constitution of cozymase was clarified by Warburg and Christian in 1936[3] and shown to be a diphospho pyridine nucleotide in which the nitrogen of the pyridine participates in the acceptance of the electrons donated from the aldehyde group of the triose.

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* A lecture delivered at University College, London, on July 5, 1946.

It is well known that the triose which donates the electrons in this enzymatic oxidation is not a free triose but a triosephosphate. However, it is important to bear in mind that the phosphate group referred to is located in the 3-position of the triose and therefore far from the site of the oxidation. Nevertheless, we ought to keep the existence of this phosphate group in mind, since it will be important in a later step-reaction. The replacement of triose by triosephosphate, thermodynamically speaking, makes little difference. However, the replacement of pyruvate by diphospho pyridine nucleotide as an electron acceptor makes some difference. The system*

$$DPN^+ \rightleftarrows DPHN$$

has a lower redox potential than the system

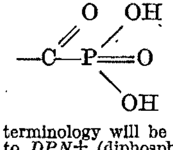
$$\text{pyruvate} \rightleftarrows \text{lactate}.$$

About 13,000 cal. are released when *DPHN* is oxidized to DPN^+ at *p*H 7. Consequently, the same amount of calories are required in reducing diphospho pyridine nucleotide to the reduced form. Thus, in the reaction

$$\text{phosphoglyceraldehyde} + DPN^+ \rightleftarrows \text{phosphoglycerate}^- + 2H^+ + DPHN,$$

13,000 cal. of the 29,000 cal. released by the aldehyde oxidation are being consumed for the reduction to the reduced cozymase. The reduced diphospho pyridine nucleotide formed can, of course, serve as a reducing system for numerous other compounds. The net free energy change at *p*H 7 of this oxidation-reduction is 16,000 cal.

A question of great significance is whether this still large amount of energy left over is available for synthetic processes. This question was attacked successfully by Needham and Green at Cambridge[4], and by Meyerhof and his group at Heidelberg[5]. These two groups have been able to show the existence of a coupling between the oxidation of triosephosphate by diphospho pyridine nucleotide and the phosphorylation of adenylic acid or adenosine diphosphate to adenosine triphosphate. Moreover, inorganic phosphate is a necessary component of this system and is consumed in the reaction. In order that phosphorylation shall proceed, oxidation is required; and the continuation of the latter reaction depends on the presence of phosphate acceptors. The two processes are therefore mutually dependent. The true nature of this interesting type of coupling has been clarified through some remarkable studies made by Warburg, Negelein and their co-workers[6,7]. These investigators succeeded in isolating a very peculiar ester, a carboxylphosphate, which is extremely labile and which is formed as the primary product in the enzymatic oxidation of phosphotriose. The discovery of this new type of phosphate ester made possible the first chemical formulation of a coupling between an oxidation and a biological synthesis based on enzyme experiments. According to this formulation, phosphate undergoes a sort of complex formation with aldehyde, and it is this complex which is oxidized, yielding a phosphorylated carboxyl group, a so-called acylphosphate.



The reaction can be expressed by the following equation:

$$\text{phosphoglyceraldehyde} + \text{phosphate} + DPN^+ \rightleftarrows \text{phospho-glyceryl-phosphate} + DPHN.$$

Warburg and Christian found that this reaction was readily reversed. They determined the equilibrium constant at *p*H 7·4 and 37°; from these data ΔF can be calculated to be between 800 and 1,000 cal. This means that as much as 15,000 cal. have been bound as chemical (or potential) energy since, as will be remembered, the oxidation of phosphotriose to phosphoglycerate, without inorganic phosphate as a participant, had $- \Delta F$ of 16,000 cal. The aldehyde phosphate complex is generally assumed to require only a smaller amount of energy and to take place spontaneously. The 15,000 cal. bound are apparently accumulated in the acylphosphate. This is further supported by the fact that the acyl compound, that is, phospho glycerylphosphate, is capable of phosphorylating adenosine diphosphate to adenosine triphosphate in the presence of a specific enzyme[8]. This reaction is an equilibrium which is far towards the side of adenosine triphosphate formation.

The bond energy of acylphosphate must be somewhat higher than the bond energy of a pyrophosphate linkage, which according to Lohmann's studies lies between 10,000 and 12,000 cal. per mole. Since the reaction between the acylphosphate and adenosine diphosphate can be reversed, it means that adenosine triphosphate is capable of phosphorylating a carboxylate group. From what was said previously, it will be understood that once the carboxyl group is phosphorylated it can readily undergo reduction to aldehyde through a labile aldehyde phosphate complex.

The old observation by Harden and Young that arsenate can replace phosphate as an activator in the cell-free fermentation and is active in minute amounts seems also to be explained by Warburg and Negelein's formulation. According to Warburg, arsenate is supposed to react with carbonyl groups like phosphate, and the only decisive difference is that the carboxyl arsenate formed by oxidation from the carbonyl complex undergoes a rapid spontaneous cleavage whereby inorganic arsenate is continuously regenerated. This spontaneous disintegration of the primary oxidation product would, of course, make the oxidation process irreversible, a fact which was actually observed by Warburg and Christian. Nevertheless, the coupling as such is supposed to exist also in the presence of arsenate and is only concealed by a secondary cleavage reaction. This example shows that the existence of numerous other important coupling reactions may be readily overlooked by reason of secondary disintegrations, non-enzymatic as well as enzymatic, of the primary reaction product formed.

Lipmann has discovered another acylphosphate which is being formed in biological oxidations, namely, acetyl phosphate[9]. This acyl compound is formed in the enzymatic oxidation of pyruvic acid:

$$\text{pyruvate} + \text{phosphate} \rightarrow \text{acetylphosphate} + 2H^+ + CO_2.$$

Acetylphosphate is also a powerful phosphate donor which is capable of phosphorylating adenosine diphosphate to the triphosphate. It has been found recently[10] that certain bacteria form butyryl phosphate in addition to acetylphosphate.

All the acylphosphates belong to the group having energy-rich phosphate bonds. This group includes adenyl-pyrophosphate (*ATP*, *ADP*), phosphocreatine and phospho-enol-pyruvate. The group of energy-rich esters is characterized by having a potential energy which exceeds that of ordinary phosphate esters many times. The ordinary ester bonds have a potential energy between 1,000 and 3,000 cal.; the energy-rich phosphate bonds are endowed with potential energies exceeding 10,000 cal. per mole.

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* The Warburg–Haas terminology will be used, namely, oxidized cozymase is abbreviated to DPN^+ (diphospho pyridine nucleotide) to indicate the quaternary nitrogen, the reduced cozymase to *DPHN* (reduced diphospho pyridine nucleotide).

The appearance of a mesomeric configuration upon hydrolysis of the energy-rich phosphate esters might be an essential feature in the liberation of the large amount of energy. However, this aspect is a matter for a physical chemist to decide. It may be sufficient to state here that a large part of the oxidation energy released by oxidation of carbonyl groups in the presence of phosphate and the proper enzyme is stored as phosphate-bond energy. In the glycolysis in which pyruvate is the electron acceptor, an extraordinarily large proportion of the energy released in the oxido-reduction is accumulated as phosphate-bond energy.

I would like to mention another example in which one has strong reasons for suspecting an accumulation of energy in a phosphate bond. I am referring to Lipmann's investigations of the conversion of 2-phospho glyceric acid to free pyruvic acid[11,2]. The essential considerations in these theoretical studies were as follows: if free glyceric acid is converted into its anhydride, pyruvic acid, a great decrease in free energy is bound to occur. It can be calculated that about 12,500 cal. are released. Yet the conversion of 2-phosphoglycerate (an enzymatically formed isomer of 3-phosphoglycerate) into phospho-enol-pyruvate is accompanied by only a negligible amount of energy liberation. The 12,500 cal. of the anhydride reaction are stored and added to the ordinary phosphate ester-bond energy. The phospho-enol bond therefore releases altogether about 16,000 cal. upon hydrolysis. Correspondingly, phospho-enol-pyruvate is capable of phosphorylating adenosine diphosphate to adenosine triphosphate, and conversely adenosine triphosphate can phosphorylate pyruvate to phospho-enol-pyruvate. It has been found recently that the particular enzyme involved in this reaction is active only in the presence of potassium ions[12]. This potassium effect is apparently quite specific.

We have seen a few examples of how the breakdown of metabolites can bring about the synthesis of powerful phosphate bonds, especially adenosine triphosphate. The energy which is accumulated in adenosine triphosphate can be used either for specific purposes or transferred to other groups. It is a well-known fact that adenosine triphosphate can exchange reversibly its terminal phosphate group with amidines (creatine, arginine) just as it does with carboxyl groups. A peculiar enzymatic reaction is the phosphate dismutation which converts 2 moles of adenosine diphosphate into 1 mole of adenosine triphosphate and 1 mole of adenylic acid. This reaction is also readily reversed.

A great deal of interest has been directed towards the dephosphorylation of adenosine triphosphate in muscle, particularly after the observation by Engelhardt and Ljubimowa in 1939 that myosin, the contractile protein of muscle, contains large amounts of adenosine triphosphatase and that adenosine triphosphate itself exerts an effect on the mechanical properties of myosin. These observations were confirmed by Bailey and by Needham and co-workers. Recently, Szent-Györgyi and his co-workers[13] have made a number of interesting observations on the properties of myosin. Only a few of their main findings can be included in this account. Straub[14] found that the myosin hitherto described is a complex protein which can be separated into myosin proper, a protein which is crystallizable, and another protein called 'actin'. Dissociation of this complex, which is called 'acto-myosin', can be brought about by adenosine triphosphate and potassium ions in the proper concentrations. In 0·02 *M* potassium chloride and in the presence of magnesium ions, the addition of adenosine triphosphate causes a spectacular contraction of threads prepared from acto-myosin. The threads are also endowed with adenosine triphosphatase activity. If the potassium ion concentration is raised, the contracted thread relaxes again. We do not know how closely this experiment illustrates the normal contraction. It is of interest, however, to add that Buchthal and co-workers have found recently that pyrophosphate compounds cause contractions in muscle fibres and that adenosine triphosphate specifically brings about changes in the double refraction corresponding to restitution.

The role which the adenosine triphosphatase takes in muscular contraction is not clear as yet. Binkley[15] has suggested that there may be an interaction between phosphate groups and sulphydryl groups, yielding thioether linkages and free phosphate. This latter state should correspond to the contracted state. The above-mentioned dissociation between myosin and actin brought about by adenosine triphosphate might then be explained by a sort of phosphorolytic cleavage of thioether linkages, yielding adenosine diphosphate, a phospho protein and free SH groups. Such a type of reaction has been described by the same author in some *in vitro* experiments with liver extracts[16].

I do not think that it is an over-statement to say that a phosphorylation of the contractile protein of some sort or another is an alternative which deserves consideration in attempting to explain the transformation of chemical energy into mechanical. The relation of adenosine triphosphate and the triphosphatase activity to the mechanical function of myosin is undoubtedly a new and interesting approach in physiological chemistry.

The irreversible transphosphorylations by which adenosine triphosphate reacts with a number of hydroxy groups play a particularly important part in carbohydrate metabolism.

It may be added that a wide variety of hydroxy compounds are being phosphorylated enzymatically from adenosine triphosphate. Glycerol is phosphorylated to glycerophosphate in extracts of kidney cortex[17]. A bacterial enzyme is capable of catalysing the phosphorylation of one of the hydroxy groups in pyridoxal from adenosine triphosphate, yielding the phosphorylated pyridoxal compound, which is an active coenzyme[18].

The enzyme which catalyses the phosphorylation of monohexoses (glucose or fructose) to form hexose-monophosphates has been known for some time and called 'hexokinase', because it initiates carbohydrate metabolism, without regard to whether this means breakdown of hexoses or polysaccharide formation.

Cori and his co-workers[10] have recently made some interesting studies on muscle hexokinase. They found that this enzyme, if isolated from diabetic animals (alloxan-diabetic rats were used), is practically devoid of activity; but if a small amount of insulin was added the activity returned. The same phenomenon was encountered if they used rat muscle from animals injected with Houssay's diabetogenic hormone from the anterior pituitary. They were also able to demonstrate the inhibitory effect of the anterior pituitary factor on hexokinase *in vitro*. Also in this case the inhibition was overcome by insulin. The muscle preparations slowly destroy the anterior pituitary factor.

If an unknown substance, belonging to the amorphous fraction of the adrenal cortical extract, is added, the action of anterior pituitary factor is enhanced and prolonged, presumably due to protection from destruction. As will be seen, most of these *in vitro* effects reproduce fairly well the *in vivo* observation made by Houssay, C. N. H. Long, F. G. Young and others. Cori emphasizes that insulin probably also has a direct effect on hexokinase, corresponding to the observation showing that hypophysectomized animals are highly sensitive to insulin.

Muscle hexokinase is apparently a rather complicated enzyme system also in other respects. Two more activators seem to be required, namely, reduced cozymase (*DPHN*) and guanine.

The ester formed by hexokinase and adenosine triphosphate is glucose-6-phosphate or Robison ester, which can be converted into fructose-6-phosphate (Neuberg ester), phosphorylated once more, and undergo cleavage and breakdown. The glucose-6-phosphate can also be converted into glucose-1-phosphate, the so-called Cori ester. The isolation of this 1-ester is of special significance, since it gave the clue to the understanding of the mechanism of the biological formation of polysaccharide. The discovery of the enzymatic formation of α-glucose-1-phosphate from glycogen and phosphate by Cori and Cori in 1936[20] represents actually the first observation of a phosphorolytic reaction (that is, a reaction by which a linkage is broken by interaction of phosphate). The replacement of water by phosphate makes a great thermodynamical difference also in this case. The hydrolytic splitting of polysaccharides is practically irreversible, whereas the phosphorolytic splitting of this group of compounds is readily reversed.

It has been found that in order to start an enzymatic synthesis of polysaccharides the presence of minute amounts of glycogen is required prior to the reaction. Cori, Cori and Green[21] have found that the synthesis of polysaccharide from glucose-1-phosphate can actually be described as a lengthening of the existing maltosidic chains. The crystalline muscle phosphorylase builds up an amylose-like polysaccharide with long chains and no extra branches. The best priming substance for this enzyme is the highly branched glycogen, which contains a comparatively large number of terminal glucose molecules. The larger the amounts of glycogen added the faster is the reaction. This reaction can be formulated as follows:

glucose-1-phosphate + terminal glucose ⇄ terminal maltosidic linkage + phosphate.

It can be seen that the phosphate of the aldehyde group is replaced by a terminal glucose through a 1-4 linkage. Doudoroff[22] has found that certain bacteria synthesize sucrose in an analogous manner, that is, according to the equation:

glucose-1-phosphate + fructose ⇄ glucose-1-fructose + phosphate.

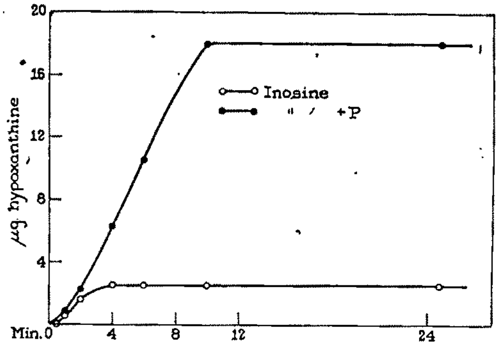

Fig. 1. EFFECT OF INORGANIC PHOSPHATE ON THE ENZYMATIC LIBERATION OF HYPOXANTHINE FROM HYPOXANTHINE-RIBOSIDE (INOSINE). ENZYME USED: NUCLEOSIDE PHOSPHORYLASE FRACTIONATED FROM RAT LIVER. THE AMOUNT OF PHOSPHATE (P) ADDED WAS 25 μGM. ORDINATE: μGM. HYPOXANTHINE LIBERATED. ABSCISSA: INCUBATION TIME IN MINUTES

On the other hand, the 1-6 polysaccharide dectran is synthesized according to a somewhat different although analogous scheme, described by the equation:

glucose-1-fructose + terminal glucose ⇄ 1-6-glucosidic linkage + fructose[23].

In this case fructose has the same role as phosphate. There is also a lævulan-synthesizing enzyme in which fructose is incorporated, and glucose takes the role of a phosphate group in replacing water and thus making the reaction reversible.

The Cori equation for glycoside synthesis apparently holds the key to a large number of important syntheses. The phosphorolytic reactions may also play a part in the biological synthesis of purine ribosides and related nucleosides. We have found recently[24] that nucleosidase, which liberates purines from nucleosides, was inactive in the absence of phosphate and could be re-activated by addition of comparatively small amounts of phosphates (see Fig. 1). This phenomenon was actually a confirmation of an earlier observation made by W. Klein in Freiburg[25]. Fig. 1 shows the great resemblance this phosphate effect bears to the Harden–Young effect and to the observations made by Cori and Doudoroff. It was natural, therefore, to assume that in this case also phosphate participated in the reaction and that a phosphate ester was formed. The search for this ester was somewhat hampered by the great lability of the new ester towards acids. The application of Lowry and Lopez's phosphate method[26] which operates at weakly acid reactions (around *p*H 4) greatly facilitated the further clarification of the enzymatic nucleoside fission. Thus one mole of phosphate was taken up in a highly labile bond for each mole of purine liberated. This relationship was found to be valid for hypoxanthine nucleosides and guanine nucleosides.

The new labile ester was isolated and analysed. It is non-reducing and contains one ribose per mole labile phosphorus. It is more acid-labile than phosphocreatine; fifty per cent of the new ester is broken down in 2·5 min. in Fiske and Subbarow's reagent at room temperature[26]. Upon acid hydrolysis, the ester becomes reducing, showing one aldose group per mole phosphate and ribose. We therefore have felt justified in calling it 'ribose-1-phosphate'. The more detailed chemical properties of this ester, particularly whether it is an α- or a β-ester, will have to be clarified by organic chemists. There is every reason to think that these problems will be solved in

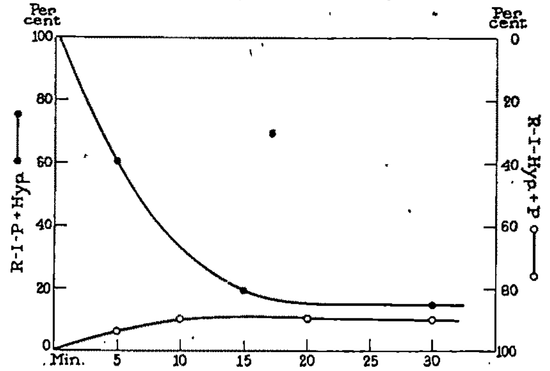

Fig. 2. EQUILIBRIUM BETWEEN A PURINE-RIBOSIDE (*R—I—Hyp*) AND THE PHOSPHO-RIBOSIDE (RIBOSE-1-PHOSPHATE, *R—I—P*). ENZYME: NUCLEOSIDE PHOSPHORYLASE FROM RAT LIVER. SUBSTRATE: EQUIMOLAR AMOUNTS OF *R—I—P* AND *Hyp* (LEFT ORDINATE) OR OF *R—I—Hyp* AND *P* (RIGHT ORDINATE). ORDINATES: PERCENTAGE OF INITIAL CONCENTRATIONS OF COMPONENTS REACTING. ABSCISSA: INCUBATION TIME IN MINUTES

the near future, by an application of the elegant technique developed recently in this field by Prof. A. R. Todd and Dr. R. J. Lythgoe.

If ribose-1-phosphate is incubated with hypoxanthine or guanine in the presence of a small amount of purified liver nucleosidase, an extensive synthesis of purine riboside takes place. The effect is particularly marked with hypoxanthine. Almost 80 per cent of the hypoxanthine is incorporated as a nucleoside. The equation for this type of reaction could be formulated as follows:

$$\text{ribose-1-phosphate} + \text{purine} \rightleftarrows \text{ribose-1-purine} + \text{phosphate.}$$

The equilibrium can be studied from both sides as illustrated in Fig. 2. The reaction is actually an enzymatic exchange between phosphate and purine. A very nearly related type of reaction has recently been described by Colowick and Price[27]. They found an enzyme in skeletal muscle which catalyses an exchange between guanine in ribonucleic acid and inorganic phosphate. The ribose-1-phosphate in the nucleic acid is even more acid-labile than that obtained from free nucleosides. Nevertheless, it has been possible to isolate small quantities of this 'deguanized' ribonucleic acid, which might also be called 'phospho-nucleic acid'. The demonstration of a guanine-phosphate cycle in nucleic acid may be important for an understanding of the biological function of nucleic acids.

I have occupied the major part of my space in dealing with *in vitro* studies and especially enzyme studies. The reason for this is mainly because these studies have taught us the intricate mechanism of the coupled oxidations and syntheses in which phosphate seems to have such an essential role. Before I finish this account, however, it seems natural to mention the ever-increasing number of studies of phosphate metabolism in various tissues *in vivo* using isotopic phosphate[28]. By means of this technique, it has been found that some of the most important phosphoric esters in muscle and liver are being rejuvenated with great rapidity[29,30]. Thus, after less than half an hour, more than fifty per cent of the phosphorus in adenosine triphosphate has been rejuvenated in the resting muscle, and only about five minutes are required to effect the same degree of rejuvenation of the adenylpyrophosphate present in liver[30]. These and many other observations bear witness to the occurrence of a very rapid uptake, transfer and liberation of phosphate in the living cells. The application of the same technique in the exploration of nucleic acid metabolism has been initiated recently by a number of investigators. These studies will undoubtedly produce many more interesting results, and perhaps be able to throw some light on the relationship between nucleic acid metabolism and cellular growth.

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BRITISH FAMILIES EDUCATION SERVICE IN GERMANY

By F. J. DOWNS

Deputy Director, British Families Education Service

HISTORICALLY, the British Army has always maintained a goodly proportion of its strength overseas on service away from Britain. In peace (and within living memory during war, too) it has been the right of the regular soldier on certain conditions to have his wife and family with him on foreign service. For more than a hundred years, therefore, it has largely fallen to the Army to provide schools for British children overseas.

In Germany to-day elements of the three Services and the civilian Control Commission for Germany are serving in what is officially described by the Services as a 'home station'. It is therefore appropriate that arrangements for the British children who have joined their parents in Germany should follow the pattern of educational arrangements in the United Kingdom, and for this purpose a civilian organisation, the British Families Education Service, was established.

The British Families Education Service has taken as its mandate the implementation of the provisions of the Education Act, 1944, for all British children in Germany in so far as conditions here permit. Departmentally, its organisation is very similar to that of a local education authority in Great Britain. The B.F.E.S. policy-forming committee is regularly composed of high ranking officers representing the users of the school service (that is, the three Services and C.C.G.) and the director of the B.F.E.S., with occasional full representation by the Ministry of Education. This local "Education Committee" in Germany has become known as "The Board of Education, B.A.O.R.", and meets regularly each month to determine how best to interpret the Education Act, 1944, for British children in Germany to-day.

The implementation of agreed policy in the light of local conditions is co-ordinated by the British Families Education Service, at its headquarters offices at Herford, and effected by the regional education officers who are stationed with their staffs at each of the Control Commission Regions in the British Zone and in the British Sector, Berlin. These regional education officers, therefore, correspond to divisional education officers in Great Britain. All British teachers working with B.F.E.S. in Germany are from schools in Britain. Many have been seconded by their local education authorities at home for periods of from one to three years, and it is a widely held view that the breadth of experience the teachers will gain from the working conditions in Germany will at least partly reward the local education authorities at home for generously agreeing to secondment at a time when they are themselves in need of all their teachers. In addition to the British teachers, some Germans are employed part-time as nursery helpers and for some specialist subjects for which there are not sufficient British staff.

The H.Q. offices of the B.F.E.S. were established in Herford on September 24, 1946. Regional offices were opened and the first British teacher arrived in Germany during November 1946. Now after about nine months there are 220 teachers at work with about four thousand British children in about seventy different places. It is thus too soon to draw any but the most tentative conclusions from this first British local education authority overseas; but one or two points are worth noting.

The majority of the children arriving here from the United Kingdom are in the lower age group. Plans for the next stage of development anticipate a child population of some 10,000, which will break down as follows: 2,000 under 3 years of age; 2,000 between 3 and 5 years of age; 4,800 between 5 and 11 years of age; 1,200, 11 years of age and over.

Thus, numerically, the problem is about the same as for a small county at home; but in Germany to-day there are additional factors which make for complication in the organisation of education for the British children. Chief of these complications is that the children are unevenly scattered throughout 20,000 square miles of territory, with outliers in the Low Countries and Berlin. In some areas there are only three or four British children, in others three or four hundred.

It will therefore be apparent that if B.F.E.S. has had to establish school groups in about seventy different places the broad pattern will be for most of the British child concentrations to be between 10 and 150 strong, with a few larger concentrations of between 150–400. In such circumstances co-education becomes a practical necessity in order to economize in teachers, equipment, materials and buildings. It will be equally apparent that whereas the nursery, infant and junior groups are usually in teachable concentrations, the effect of uneven scatter on the smaller secondary population is, locally, to leave a large number of embarrassingly small 'senior tops' to the primary groups. This very inadequate solution is naturally only acceptable as an interim means of giving education on quasi-Dalton plan lines to children of secondary school age who have been brought to Germany in advance of arrangements being made for adequate secondary education.

So the B.F.E.S. has come to the conclusion that the only way that most of the British children over 11 years of age can receive satisfactory secondary education suitable for their age, ability and aptitude is by attending boarding schools. Accordingly, on July 1, 1947, the first publicly maintained co-educational secondary boarding school was opened at Wilhelmshaven in premises recently vacated by the Royal Navy.

The B.F.E.S. Prince Rupert (Secondary) Boarding School, Wilhelmshaven, will cater for 250 boys and girls. It is calculated that at least two further boarding schools of similar size (or rather larger) will be needed to provide education for those children of secondary age who can only be offered appropriate education in boarding schools. The demand undoubtedly exists among parents, more than four hundred having applied within a week of the first announcement about Wilhelmshaven; and further secondary schools will be established immediately B.F.E.S. is offered suitable buildings. It now seems likely that it may be possible to open a second large boarding school by Christmas. Apart from secondary education in boarding schools it has been found possible to establish a day secondary element of reasonable size in Hamburg, and necessary, because of its isolation, to have a similar secondary element in Berlin. Outside Wilhelmshaven, Hamburg and Berlin, B.F.E.S. teachers are only at the moment able to make *ad hoc* time-marking arrangements for children of secondary school age, and so the position will remain until further buildings are made available for secondary boarding schools.

Scattering has not complicated the establishment of primary school groups to anything like the extent that it has conditioned the basis of secondary provision. Primary groups are therefore being established to a more familiar pattern, though the school buildings on the whole are somewhat unexpected, and bear more resemblance to the conventional idea of 'private academies for young gentlefolk' charging expensive fees than to State schools charging nothing.

Scatter in most places has necessitated that British children attending day schools are collected in buses. Although distances are carefully watched, and the very young children are not allowed to travel, it is often inevitable at this stage that some children travel farther to school each day than is normally desirable. So, for economy of time and effort alone a school meals service would have been desirable in Germany to avoid a double midday journey, even were there not even stronger social training reasons for its institution. The B.F.E.S. school meals scheme for all school groups officially began early in May 1947 on a basis of container meals cooked in the nearest mess and transported to the school for the children to take their midday meal there. Later, as kitchens are prepared and equipped each school group will have its own cooking arrangements, as some already have.

B.F.E.S. has also instituted a school library service of several thousand volumes circulated in a hundred specially designed travelling showcases, which are used as portable lending libraries on arrival at the schools.

Now that B.F.E.S. is settling in, we are all very conscious that there is a long way to go and many problems to solve before the Education Act, 1944, is a complete reality for every British child in Germany. Books are still lamentably short, and starting as we are from scratch there are no past stocks on which to draw. There is certainly a lower limit below which book supplies should never fall; but anyone who has seen the improvisations and class teaching of B.F.E.S. teachers who can only, at the moment, be supplied with a small percentage of the books they want, may reach the conclusion that schools and school teachers have tended to put this lower limit too high. Like books, furniture and equipment is neither fully in position nor, in every case, to the requested specification of B.F.E.S.: each month, however, sees improvement.

School organisation is also seriously complicated by the movement of families, and here the Services are the chief offenders. One boy of nine, for example, had been in six different schools at various Army stations, while one B.F.E.S. school lost overnight twenty children from one regiment to receive in exchange twenty-five children from another. At the same time continual movement on any scale may well necessitate a degree of standardization of curriculum and text-books in order that the movement of children from one school to another can be accomplished as smoothly as possible. Similar standardization was forced upon Army schools, which have had continually to cope with the same problem.

It is far too early to estimate the psychological effect of residence in Germany on the British children. It is unhappily true that values are awry here to-day, and the British child may well get a sense of power which he is ill-adapted to assume. His few sweets, for example, have appreciable 'black market' purchasing power; the eagerness to do his bidding on the part of servants at home and in the families' clubs may breed in him an unnecessary arrogance; he may find, expediency being what it is, that a German boy may be cuffed by him without hitting back. Alternatively, he may find his sympathies overplayed and his outlook distorted by the many sights that can and have done both to adults working in Germany to-day.

Nevertheless, when all possible difficulties are appreciated a great deal remains on the credit side. The British schools in Germany can provide the German people with a very positive demonstration of British education in practice in their midst; and the behaviour of our children will be watched equally with the curriculum, as the behaviour of our occupation forces is at least as important as our formal laws and ordinances. For the British children themselves there is a profound potential for good in their attending a British school in Germany to-day. They will probably emerge bi-lingual, they will have wide opportunities for exploration, and they should emerge with a wider and more elastic attitude to their work, for their real joy in being at school is very apparent. Fundamentally, the chief determinant of whether bringing the children to Germany was a good or bad thing will be the quality of the British education provided here. This, in its turn, is a reflexion not merely of the printed word of the Education Act, but also of the skill and enthusiasm of the teachers in putting it into effect in the schools.

In its teachers, B.F.E.S. has been more than fortunate, and we all hope and believe that they themselves will benefit from the experience of a stay in Germany at least in proportion to the willing and excellent service they are giving the British children in Germany to-day.

NEWS and VIEWS

Hydraulic Research Organisation: Sir Claude Inglis, C.I.E.

With the appointment of Sir Claude Inglis as director of the new Hydraulic Research Organisation, the proposal to form a National Hydraulics Laboratory in Great Britain moves one more step towards realization. Sir Claude's work in India, where for many years he has been the leading exponent of the systematic use of models in the design of large civil engineering works, is known throughout the hydraulic laboratories of the world. He became director of the Central Irrigation and Hydrodynamic Research Station (now the Indian Waterways Experiment Station), Poona, in 1937, when it was taken over by the Government of India, and there, and in his previous capacity as superintendent engineer of the Research Division of the Bombay Irrigation Service, he has been responsible for the solution of a wide range of problems in river control: for example, the safeguarding, in 1934, of the Harding Bridge on the Ganges, where previously repairs alone had cost nearly a million pounds in two years, and the determination of the origin and remedy for the flooding of the Indus in 1942. Earlier, as assistant engineer or as executive engineer, Sir Claude was in charge of the construction of many works, including the building and remodelling of several canal systems in the Deccan. Such constructional experience should ensure that practical difficulties will be given full attention in the designs emanating from his Laboratory.

Perhaps the most important application of hydraulic work lies in the botanical and agricultural fields, and Sir Claude has had long experience in this, for in 1913 as executive engineer of the Poona Irrigation District he was reporting upon salt-saturation of soils arising from irrigation and evaporation; also at about that time he was responsible for introducing new and successful methods in connexion with land drainage and reclamation in the Deccan. His publications on hydraulics include such subjects as river meander, river training, scale effects and the use of distorted models, and he has been responsible for technical reports on very many irrigation, river and coastal works, many of which have been printed in the Annual Reports (Technical) of the Indian Waterways Experiment Station.

Metropolitan-Vickers Electrical Co., Ltd.: Dr. C. Dannatt, O.B.E.

Dr. C. Dannatt has been appointed chief electrical engineer of the Metropolitan-Vickers Electrical Co., Ltd., in succession to Mr. G. A. Juhlin, who has resigned, though retaining his connexion with the Company. Dr. Dannatt received his technical education under Prof. W. M. Thornton at Armstrong College, Newcastle, from which he graduated in electrical engineering in 1921. His studies were interrupted by the First World War. Dr. Dannatt went to Metropolitan-Vickers as a college apprentice in 1921 and afterwards joined the electrical and magnetic section of the Research Department, taking charge of the section in 1924. His activities have been mainly concerned with engineering investigations, and he is a recognized authority on electrical measurements especially in relation to magnetism and the behaviour of dielectrics. He is the principal author of a volume on "Electrical Power Transmission and Interconnection". In 1936 he was awarded the degree of D.Sc. by the University of Durham. Dr. Dannatt was appointed to the chair of electrical engineering in the University of Birmingham in August 1940; but at the request of the Admiralty he continued part-time activities with the Metropolitan-Vickers Co.; in the New Year Honours List of 1943 he was awarded the O.B.E. for contributions to naval gunnery. In 1944 he returned to Metropolitan-Vickers as assistant to the chief electrical engineer, and in the following year he was appointed deputy chief electrical engineer.

Mining and Metallurgy at Adelaide: Prof. E. C. R. Spooner

The Council of the University of Adelaide has appointed Dr. Edgar Clynton Ross Spooner to be professor of mining and metallurgy and director of the Bonython Laboratories at the South Australian School of Mines and Industries, in succession to Prof. H. W. Gartrell, who died two years ago. Prof. Spooner, who is thirty-nine, was born and received his undergraduate education in Tasmania, and was Tasmanian Rhodes Scholar in 1931. At Oxford he carried out research into electrode potential phenomena, for which he was awarded the degree of doctor of philosophy in 1936, and in 1946 the University of Tasmania conferred on him the degree of doctor of science for further research work in that field. On leaving Oxford, Prof. Spooner was for two years technical assistant to the works director of the National Smelting Company, Avonmouth, and then for seven years technical superintendent and works manager, and later assistant general manager, to the Magnesium Metal Corporation, Ltd., Swansea. Since December 1944 he has been technical adviser to S. G. Warburg and Company and director of research and development to Sutcliffe, Speakman and Company. In 1946 he was a member of the British Industrial Mission which investigated and reported on the active carbon industry of Germany.

Defence Scientific Advisory Committee, Australia

It was announced in *Nature* of June 28, p. 869, that Mr. A. P. Rowe had been appointed to take charge of a scientific advisory committee for defence in Australia. The United Kingdom Government has agreed to loan Mr. Rowe's services for a period of one year to the Australian Government for the purpose. Mr. Rowe will carry out the functions of defence scientific adviser in Australia and will establish a Defence Scientific Advisory Committee of which he will be chairman. The Committee will be constituted as follows: Defence Scientific Adviser, a representative of the Council for Scientific and Industrial Research, and one representative each of the following subjects—physics, chemistry, engineering and medicine; specialist Service and munitions representatives and scientific workers will be co-opted as required. The functions of this Committee will be to maintain a general survey of the scientific field and bring to the notice of the Defence Committee and the Chiefs of Staff Committee or through the Council of Defence to the Government, scientific developments having either direct or indirect bearing upon national defence.

British Hat and Allied Feltmakers Research Association: Dr. Thomas Barr

Dr. Thomas Barr has been appointed director of research to the British Hat and Allied Feltmakers Research Association. This newly formed Research Association will carry out investigations on problems provided by members of the felt-hat industry. Initially, the work of the Association will be carried out in accommodation provided by the Textile Industries Department of the University of Leeds. The location of the new research group at Leeds should prove an attraction and stimulus, since for the past quarter of a century Leeds has been one of the most active centres of both fundamental and applied research on animal fibres. Dr. Barr is at present in charge of a research section in the I.C.I. Dyestuffs Division, carrying out fundamental research work on textile processes involving the study of cellulose, natural and regenerated, the modification of wool and physiochemical studies of colloidal electrolytes such as synthetic detergents, etc.

'Sponsored' Research for Industry

In his address when opening the Fulmer Research Institute at Stoke Poges on July 2 (see p. 165), Sir Stafford Cripps said that the new Institute, which is constituted broadly on lines similar to the Mellon Institute in the United States, may well be the prototype of a kind of research organisation which could largely fill the gap between scientific research and its application in production processes, particularly for the smaller firms. There are, he said, three essential principles in any research institute which seeks to perform this general function for industry: its staff and equipment must be first class; the results of research sponsored by an individual firm must be retained by that firm, either as patents or as general technique and knowledge; and thirdly, the Institute should not be profit-making. Research and profit-making, he believes, do not mix well together, and although research should be carried out with reasonable economy, and elaborate equipment may not be necessary, it must be allowed ample time and a wide range of experimental failure. All these principles have been adopted in setting up the Fulmer Research Institute, and it has also been arranged for members of the staff of the sponsor firms to go and work in the Institute so as to be in a position to translate the results of the research readily into terms of factory processes. Sir Stafford Cripps also commended the Institute for the economy in scientific effort and said that the Government heartily welcomes this initiative as filling the gap which will be left even when joint research organisations have been set up as contemplated under the new Industrial Development and Organisation Act. In the first instance, the Fulmer Research Institute will concentrate upon metallurgical research, though other fields will be entered as the work develops.

University Teaching in Agriculture and Horticulture

In reply to a question asked in the House of Commons, the Minister of Agriculture, Mr. T. Williams, stated that the universities of Britain are sympathetic in principle with the proposals of the Committee on Higher Agricultural Education for raising the standard of degree courses in agriculture and horticulture, and have carefully noted the detailed suggestions in the report relating to the form and content of the courses. The Committee's comprehensive plan for the development and allocation of graduate courses is generally acceptable to the universities, some of which are hoping to introduce courses on the lines suggested this year or next. The main administrative recommendation of the Committee was that responsibility for grants in aid of higher agricultural and horticultural education at universities should be transferred from the Ministry of Agriculture to the University Grants Committee as from the beginning of the academic year 1947–48, on the understanding that the University Grants Committee would set up a specialist sub-committee to provide it with the necessary technical advice. Mr. Williams said that after consultation with the universities and with the Treasury he has accepted this recommendation, though he will naturally retain a close interest in the development of university teaching in agriculture and horticulture.

The constitution of the Agricultural Sub-Committee appointed by the University Grants Committee is as follows: Dr. A. E. Trueman (*chairman*), J. M. Caie, Prof. N. M. Comber, Sir Frank Engledow, Sir John Fryer, Sir Bryner Jones, Dr. Thomas Loveday, Prof. H. A. D. Neville, Dr. W. G. Ogg, Frank Rayns, Prof. E. K. Rideal, Sir Edward Salisbury and Dr. Norman Wright.

Foot-and-Mouth Disease Research Committee

The Minister of Agriculture and Fisheries has reconstituted the Foot-and-Mouth Disease Research Committee with the following membership: Dr. A. N. Drury (*chairman*), director of the Lister Institute of Preventive Medicine; Dr. C. H. Andrewes, of the scientific staff of the National Institute for Medical Research and a fellow of the Royal Society; Prof. S. P. Bedson, Goldsmiths' professor of bacteriology in the University of London at the London Hospital Medical College; Sir Daniel Cabot, chief veterinary officer of the Ministry of Agriculture and Fisheries; Mr. T. Dalling, director of the Ministry of Agriculture and Fisheries Veterinary Laboratory at Weybridge; Dr. R. E. Glover, director of the Laboratory Animals Bureau, Medical Research Council; Dr. Russell Greig, director of the Moredun Institute of the Animal Diseases Research Association, Edinburgh. Dr. I. A. Galloway, director of the Foot-and-Mouth Disease Research Station, and Mr. F. A. Eveleigh, of the Ministry of Agriculture, have been appointed secretaries to the Committee. The terms of reference of the Committee remain as follows: "To initiate, direct, and conduct investigations into foot-and-mouth disease either in this country or elsewhere, with a view to discovering means of rendering the invasions of the disease less harmful to agriculture".

Historical Library, Yale University School of Medicine

The sixth annual report of the Historical Library, Yale University School of Medicine, to which are appended the Chief Cataloguer's report and a list of the Monograph series issued by the Library, covering the year ended June 30, 1946, summarizes the principal points in the Library's plan for the next five years. This plan is based on the conviction that with the growing importance of science in the curricula of universities as well as in national life and international thought, greater stress must be placed upon the history of science and upon the humanistic values attached thereto. One of the primary aims of the new plan is to make the Historical Library the University's centre for historical studies in medicine and the allied sciences. For this purpose it is planned to augment Yale's holdings in medicine and allied sciences and, in co-operation with the University Library, to make them freely available throughout the University. The report directs special attention to some of the present holdings of the Library, such as those in the history of astronomy, geology, and early physics; and in particular the special collections in chemistry which, in addition to the works of Robert Boyle, John Mayow, Luigi Galvani, Alessandro Volta, Joseph Priestley and Antoine-Laurent Lavoisier, include all the writings of Sir Humphry Davy. The Library also has extensive Linnean holdings, and has concentrated heavily on the history of scientific societies in the seventeenth century. The new plan contemplates the creation of a chair of the history of medicine and science, and the extension of the Library's publications, both the Monograph series and the series of papers on bibliography and the history of medicine, as well as frequent exhibits of books, manuscripts and museum holdings.

During the year 1945–46, the Library staff formulated plans for a new periodical, the *Journal of the History of Medicine*. Distinguished visitors were received from many parts of the world, and space was assigned for editorial offices of *Cancer Research* and of the history of the U.S.A. Typhus Commission. The Library was actively associated during the year with the compilation of the Bibliography of Scientific, Medical and Technical Books, issued by a committee of the National Research Council, with an amplified translation of Dr. A. Castiglioni's "Adventures of the Mind", and with Mrs. M. L. Duran-Reynal's monograph on the history of quinine.

Demonstration Models of Physical Processes

Two interesting models, originally designed for exhibition in the Science Museum, London, have been described by Dr. F. A. Ward (*Proc. Phys. Soc.*, Jan. 1947). The first illustrates, by an optical analogy, the principle of the Bragg X-ray spectrometer, namely, that a monochromatic beam of X-rays will be reflected by a single crystal only when the crystal is set at a particular angle to the incident beam such that reflexions from successive sheets rich in atoms are in phase and so give an interference maximum. The incident beam is represented by a sheet of corrugated iron, and the crystal to be analysed by four glass plates mounted on a wooden rack. The observer looks into the glass plates, and rotates them until the virtual images of the crests of the corrugations appear to coalesce. The second model is a mechanical one illustrating the uranium chain reaction which has been utilized for the release of atomic energy. It consists of thirty units, each representing the nucleus of an atom of uranium 235 or plutonium. A unit consists of two portions held together by a catch which, when released, allows the two portions to fly apart, while at the same time projecting upwards three table-tennis balls representing neutrons. A single 'neutron' dropped on the catch of one of the units disintegrates this unit, and the three ejected 'neutrons' impinging on neighbouring units cause them to disintegrate, thus initiating the chain reaction. Both these models have been demonstrated at the Physical Society's science meetings, at the Society's Exhibition of Scientific Instruments and Apparatus, and also at the recent Royal Society conversazione, where they have aroused considerable interest.

Beit Memorial Fellowships for Medical Research

The Trustees of the Beit Memorial Fellowships for Medical Research have received with regret the resignations of Lord Rayleigh and Lord Macmillan of Aberfeldy; Sir Henry Dale and Lord du Parcq have been appointed to succeed them. The following elections have been made: *Fourth Year Fellowship* (£700 a year): F. Sanger, to study the structure of proteins with special reference to insulin (at the Department of Biochemistry, University of Cambridge). *Junior Fellowships* (normal value £600 a year): J. W. Lyttleton, to study the purification and subsequent physico-chemical characterization of proteins involved in the coagulation of blood (at the Lister Institute of Preventive Medicine, London); A. J. Marshall, to study the humoral and nervous control of the decidual reaction of the mammalian uterus (at the Department of Zoology and Comparative Anatomy, Oxford); L. Silberman, to study the community costs of tuberculosis in terms of public assistance and industrial outlay to patients and dependants, man-day wastage and social service provisions with special reference to the problem of reinstatement and revocation (at the University of Birmingham); Dr. G. Weber, to investigate the reactions and behaviour of physiologically important proteins (at the Sir William Dunn School of Biochemistry, University of Cambridge).

Institution of Electrical Engineers: Awards

The Council of the Institution of Electrical Engineers has made the following awards of premiums for papers read or accepted for publication during the session 1946–47. Group A: *Institution Premium:* Dr. H. G. Booker; *Kelvin Premium:* Dr. H. A. H. Boot and Prof. J. T. Randall; *John Hopkinson Premium:* H. A. Thomas. Group B: *Non-Section Premiums:* J. R. Mortlock and C. M. Dobson (Ayrton Premium), J. Hacking and J. D. Peattie (Llewellyn B. Atkinson Premium), C. H. Sparks (Extra Premium); *Installations Section Premium:* V. J. Francis and W. R. Stevens (Crompton Premium), F. Widnall and R. Newbound (Swan Premium), C. F. Freeman and H. V. Mather (Extra Premium); *Measurements Section Premiums:* W. Casson and Dr. F. H. Last (Silvanus Thompson Premium), Dr. F. M. Bruce (Mather Premium), Dr. A. L. Whiteley (Extra Premium), G. H. Farrington (Extra Premium), Dr. A. M. H. Arnold (Extra Premium); *Radio Section Premiums:* Dr. D. C. Espley, E. C. Cherry and M. M. Levy (Duddell Premium), C. Crampton (Extra Premium), W. Ross (Ambrose Fleming Premium), Dr. D. Gabor (Extra Premium), J. Bell, M. R. Gavin, Dr. E. G. James and G. W. Warre (Extra Premium), C. J. Banwell (Extra Premium) Dr. J. H. Fremlin, A. W. Gent, D. P. R. Petrie P. T. Wallis and Dr. S. G. Tomlin (Extra Premium) D. Cooke, Z. Jelonek, A. J. Oxford and E. Fitc (Extra Premium); *Transmission Section Premiums* G. T. Garwood (Sebastian de Ferranti Premium) T. R. P. Harrison (John Snell Premium), R. C. Cuff (Extra Premium). Group C: *Fahie Premium* E. P. G. Wright; *Paris Exhibition* (1881) *Premium* W. Fordham Cooper; *Webber Premium:* W. E. C Lampert; *Overseas Premium* (for senior members) T. S. Skillman.

Announcements

The First Class of the Order of Agriculture ha been conferred on Dr. W. Lawrence Balls, recentl chief cotton technologist of the Egyptian Ministr of Agriculture, by the King of Egypt on the occasio of his resignation from that country's service.

Prof. Arthur Holmes, regius professor of geolog in the University of Edinburgh, has been elected member of the Section of Natural Sciences of th Royal Netherlands Academy of Sciences.

Prof. Gustave Ribaud, professor of pyrometr in the University of Paris, has been elected a membe of the Section of General Physics of the Pari Academy of Sciences.

In connexion with the recent International Physiological Congress, the University of Oxford conferre the honorary degree of D.Sc. on the following: Pro S. A. S. Krogh, emeritus professor of zoophysiolog in the University of Copenhagen; Prof. A. Szent Györgyi, professor of biochemistry in the Universit of Szeged; Dr. H. S. Gasser, director of the Rockefeller Institute for Medical Research; Prof. B. A Houssay, recently professor of physiology in th University of Buenos Aires; and Dr. C. H. Bes professor and head of the Department of Physiolog University of Toronto.

Profs. A. C. Chibnall, G. R. Cameron and D. Brun have been appointed members of the Agricultur Research Council. Sir Frank Engledow and Pro James Gray retired from membership of the Counc on July 1 on the expiry of their terms of office.

Dr. C. L. F. Hunter has been appointed by P Chemicals, Ltd., as director of the Bray Researc Station, which is carrying out research into agricu tural problems.

Dr. Frans Verdoorn, managing editor *Chronica Botanica*, has been appointed an honorar staff member of the Government Botanic Garden Buitenzorg, Java, on the occasion of the hundred an thirtieth anniversary of the Garden on May 18, recognition of his work, during the war years, behalf of the scientific institutions of the Netherlan Indies.

The following appointments in the Colonial Servi have been announced: R. B. Blyth, to be supe intendent of agriculture, Nigeria; J. L. Congdo to be agricultural officer, Aden; H. W. Dougall, be agricultural chemist, Sierra Leone/Gambia; J. Waterston (plant pathologist, Bermuda), to be seni botanist, Nigeria; L. R. Langridge (senior surveyo Nigeria), to be divisional surveyor, Nigeria; E. Stanfeld (director of surveys, Jamaica), to be supe intendent, Crown Lands and Surveys, Hong Kon

LETTERS TO THE EDITORS

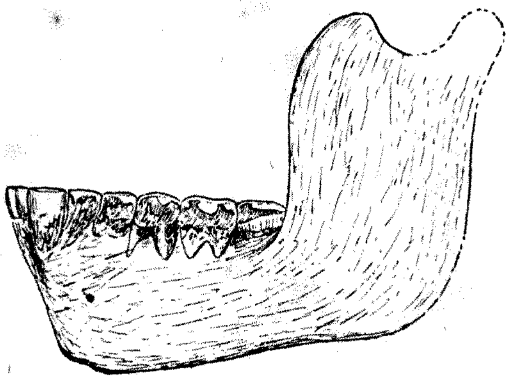
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Jaw of the Male Sterkfontein Ape-man

On June 24, we blasted out at Sterkfontein, at a spot only about 8 ft. away from where we discovered the old female skull of *Plesianthropus*, the almost perfect lower jaw of a large male. The left mandible is complete except for the loss of the condyle and a little part of the margin of the angle. The whole symphysial region appears to be complete, while the right ramus is much broken and crushed. All the teeth of the left side are present, though worn.

The horizontal ramus is considerably larger than that of man but essentially similar. The ascending ramus is higher than in man, but otherwise not unlike that of the human jaw.

The front of the jaw is remarkably interesting. It does not slope rapidly backwards as in the living anthropoids but more downwards than backwards, giving an appearance not unlike that of the Heidelberg jaw. The front of the Sterkfontein jaw is narrower owing to the incisors being smaller. The symphysis, so far as can yet be seen, seems to agree fairly well with that of the Heidelberg jaw, and there appears to be no simian shelf.



True side view of mandible of male *Plesianthropus transvaalensis* (Broom). ½ Natural size

The molars are badly worn along their outer sides. The canine has its crown ground down quite flat and in line with the other teeth. Parts of the outer sides of the premolars are in the counter slab and will later be replaced

The molars and premolars are much larger than in the Heidelberg jaw, and the canine very much larger. The molars and premolars are much worn. In the case of the 1st and 2nd molars, the whole outer sides of the crowns are worn off; but on the inner side parts of the enamel cusps still remain.

The canine is the most interesting tooth of the jaw. We know the unworn lower canine crown in the male *Plesianthropus*. It is much larger than in man and has a well-developed and pointed main cusp and a small posterior cusp. In the female the upper canine we knew was worn down as in man, but in the male it was suspected that the lower canine passed in front of the upper as in the anthropoid apes. Now we find that the lower canine, while it may in the young animal pass up in front of the upper, is ground down, as age advances, by attrition with the upper, exactly as in man. The whole jaw is thus practically a human jaw.

This jaw is much too large to have fitted the elderly female skull recently discovered; and the skull that belonged to this jaw must have been remarkably large. If a restoration of the skull is made from the known female skull, but large enough to have fitted this jaw, it is seen that we have a skull that is nearly human.

The brain of the female skull was only about 450 c.c., but the male skull that belonged to this jaw must have had a brain of 600 c.c., or perhaps even 700 c.c.

Another interesting point is that on the lower part of the front of the jaw there is a little bony thickening which might be regarded as an incipient chin.

This jaw seems to us to be of considerable importance on the question of man's origin.

R. Broom
J. T. Robinson

Transvaal Museum,
Pretoria, South Africa.

July 3.

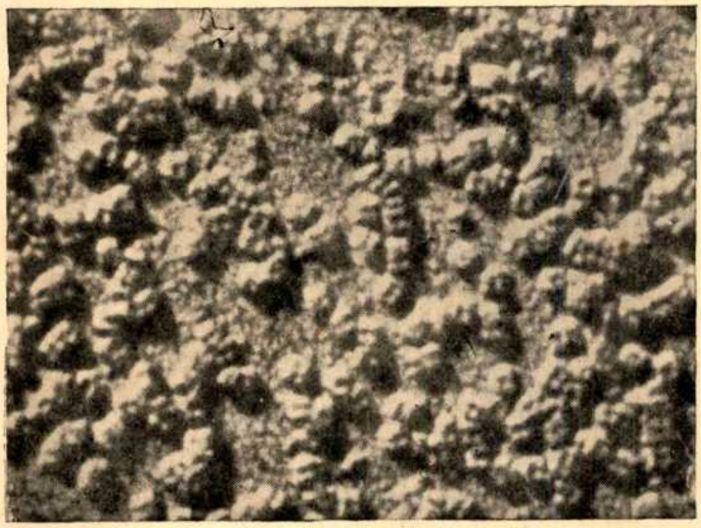
Shape of Hæmocyanin Molecules

In a previous communication[1] it was shown that the electron microscope can record the individual molecules in a solution of the respiratory protein from *Limulus polyphemus*. An unexplained feature of these photographs was the fact that the diameters of the molecular images were not uniform but showed considerable spread about a mean value. Hæmocyanins from several invertebrates have been under study in this laboratory partly to provide an interpretation of such apparent variation in molecular size and partly to see the reason for the reversible changes in molecular weight that have been established[2] through ultracentrifugal analysis.

Special attention has been given to the hæmocyanin from *Busycon canaliculatum*, living specimens of which were kindly provided by the Fish and Wild Life Service of the U.S. Department of the Interior. This hæmocyanin was selected because of its great molecular weight. Its published pH stability diagram records components with sedimentation constants of 130, 102, 61 and 13·5 Svedberg units, the two heavy components being absent at pH values above about 9. The principal component in freshly drawn 'blood' seems to be the one with the sedimentation constant 102 and an estimated molecular weight 6,800,000, but the existing data do not record the relative proportions of these components.

Electron micrographs have been made of fresh *Busycon* hæmocyanin and of this protein purified by ultracentrifugation. The pH of the solutions was established by adding minimal amounts of phosphate buffer and dialysing against distilled water to remove excess salt. Preparations for electron microscopy were made by putting these solutions and dialysates on the usual collodion-covered screens or by spreading them on glass slides for atomic replication. Shadowing was with gold at a 6–1 angle; photography was carried out with an R.C.A.-type *EMU* instrument.

Sufficiently diluted hæmocyanin near its natural pH yields an electron micrograph such as that reproduced herewith. Its single molecular particles are obviously uniform and possess a well-defined internal structure. Careful examination indicates that each large particle consists of rod-like sub-units stacked together, apparently in bundles of four. The sub-units are about three times as long as they are thick and have pairs, or all four, of their long axes parallel. This gives a cube-like composite particle of constant dimensions. At some places on the photograph the molecules are situated so that one looks down on the ends of four rods; at others the molecules are turned over so that two rods are seen lengthwise. At a few places one pair of rods seems to be rotated 90° with respect to the other, so that a tetrad shows the ends of two rods and the side view of another. The elongated sub-units can be discerned in all but the most alkaline preparations, but at higher pH the tendency to form tetrads has disappeared. At values of pH higher than about 10 the rods are replaced by very small particles which apparently result from their disintegration. It has not been possible to reconstitute larger molecules by adding acid to these strongly alkalinized solutions.



A GOLD-SHADOWED REPLICA OF A DILUTE SOLUTION OF HÆMOCYANIN FROM *Busycon canaliculatum* SPREAD ON A GLASS SURFACE. INDIVIDUAL MOLECULES ARE THE CUBE-LIKE OBJECTS ABOUT 3 MM. IN DIAMETER. × 77,000

A conspicuous and rather unexpected result of these experiments is the ease with which enough molecular damage can be done to interfere with the orderliness of this particle association. Removal of the last traces of salt by dialysis has brought about this measure of denaturation, and so has treatment with strong salt or purification by repeated sedimentation in the ultracentrifuge. The electron microscope offers an especially sensitive way of studying this type of minimal denaturation.

A detailed investigation is now under way of the molecular structures and stability ranges of fresh solutions of several typical hæmocyanins using both the electron microscope and the analytical ultracentrifuge. Preliminary results already demonstrate that in *Busycon* hæmocyanin undamaged molecules are uniform in size. The largest are regular groupings of smaller rod-shaped units, the associations and dissociations of which are responsible for the different molecular weights determined by the analytical ultracentrifuge.

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[1] Williams, R. C., and Wyckoff, R. W. G., *Nature*, **156**, 68 (1945).

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Autotrophic Growth of Sulphate-Reducing Bacteria

Starkey and Wight[1] have reported reduction of sulphate to sulphide by *impure* cultures of sulphate-reducing bacteria growing in a strictly mineral medium containing sodium bicarbonate as sole carbon source, and in the presence of molecular hydrogen. It was not shown conclusively that pure cultures could grow in these autotrophic conditions.

At the time when Starkey and Wight's report became available in Great Britain (July, 1946) work was proceeding in this Laboratory on pure cultures of sulphate-reducing organisms in connexion with their role in anaerobic microbiological corrosion. Experiments were immediately initiated to determine whether these pure cultures are able to grow autotrophically. Pure cultures of four strains of *Vibrio desulphuricans*, isolated from different sources and exhibiting distinctive morphological characteristics, were subcultured into a medium containing sodium bicarbonate as sole source of carbon, ammonium chloride as nitrogenous nutrient, dipotassium hydrogen phosphate, calcium sulphate, magnesium sulphate, and a trace of ferrous salt. They were incubated at 30° C. in an anaerobic jar containing an atmosphere of hydrogen with 5 per cent carbon dioxide. At first, growth was obtained with one strain only; but successful attempts were made with the other three strains to acclimatize them to growth in media containing gradually decreasing quantities of lactate (the usual source of carbon for heterotrophic growth of sulphate-reducers). This procedure has now been found to be unnecessary, and growth has been obtained with all four strains by direct inoculation into the mineral medium. Growth is accompanied by reduction of sulphate to sulphide, which is clearly shown by precipitation of ferrous sulphide.

In final and conclusive experiments, stringent precautions were taken to ensure the absence of organic material. All glassware used in the preparation of media and for culture vessels was washed in chromic acid and finally in conductivity water. The cotton-wool plugs normally used in medium flasks and in culture test-tubes were replaced by loosely fitting beakers or tubes washed in chromic acid. Pipettes, instead of being wrapped in paper and dry sterilized, were placed inside large glass tubes and autoclaved. The medium was made up with 'Analar' chemicals and conductivity water. Good growth was obtained and has persisted through many subcultures, thus obviating any 'carry-over' effect of organic material from the original inoculant (2 drops). Numerous platings-out on various media incubated both aerobically and anaerobically have shown the cultures to be quite pure at all stages.

Stephenson and Stickland[2] have shown that resting non-proliferating cells of a strain of sulphate-reducing bacteria isolated by them contained an enzyme system capable of causing the reduction of sulphate to sulphide by means of molecular hydrogen. They found that the hydrogen absorbed was equivalent to the sulphate reduced and the hydrogen sulphide formed. Under their experimental conditions no growth occurred; but presumably the energy for autotrophic growth of the four strains is obtained by the oxidation of hydrogen brought about by the same or similar enzyme system. As one would expect, all attempts to cultivate the strains anaerobically in the mineral medium alone, in the absence of hydrogen, have failed. When, however, rods of carefully cleaned sterile mild steel are placed in the inoculated mineral medium and incubated at 30° C. in a closed jar containing alkaline pyrogallol for absorption of oxygen, definite growth occurs with reduction of sulphate to sulphide. As suggested by Starkey and Wight[1], who obtained similar results with contaminated cultures, it is probable that hydrogen is formed by reaction of the steel with water, and its oxidation supplies the energy for growth.

Similar autotrophic growth, both in mineral salt solution with hydrogen atmosphere and in mineral salt solution with immersed steel rod, has been obtained with a thermophilic strain of sulphate-reducers at 55° C.

It can therefore be concluded, in the light of Starkey and Wight's and our own experiments, that sulphate-reducing bacteria may be regarded as facultative autotrophs.

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Gonads and Experimental Tuberculosis

Results, obtained to date, by different authors on the investigation of the influence of the sexual organs in experimental tuberculosis vary very much indeed. Mautner[1] and Bricker[2] admit that castration prolongs the life of the inoculated animals, whereas Brack and Gray[3] and Long and Vogt[4] deny such results. Vercesi and Merenda[5], Gray and Brack[6] and Long and Vogt[4] maintain that injection of œstrogens does not modify the course of experimental tuberculosis. Carnes and Biskind[7], who administered testosterone, reach the same conclusion. Most of these investigations have been carried out with very small groups of animals, and in others the results have been observed a few days after the inoculation; thus it has not been possible to define with precision the reaction of the animals to the tuberculous infection. Studies were carried out by us in the guinea pig to establish not only the type of pathological lesions, but also the survival-rate of the animals. These animals were grouped in the following manner: 20 castrated animals, 10 males and 10 females; 20 non-castrated females, which were injected intraperitoneally with 50 μgm. of œstradiol dipropionate three times a week; 20 non-castrated males, injected intraperitoneally with 250 μgm. of testosterone propionate three times a week; 20 control animals. All these animals were injected subcutaneously with 1 c.c. of an emulsion which contained 0·1 mgm. of tubercle bacilli of the human type.

The castrated guinea pigs showed an increased survival-rate as compared with the controls. During the course of the second month 10 per cent of the castrated animals had died, as compared to 30 per cent of the control group. In the fourth month 35 per cent of the castrated animals had died, as compared with 90 per cent of the controls. In the seventh month all the control group had died, as against only 60 per cent of the castrated group.

The pathological lesions found were characteristic of fibrocaseous involvement, whereas in the castrated animals there was a tendency towards lesions of the fibrous type. Animals injected with œstradiol or testosterone showed identical mortality figures with those of the control group; but the lesions were much more extensive and of the caseous type. The influence of the gonads on tuberculosis could be explained by the indirect action that the hypophysis exerts on the thyroid. Castration produces in the hypophysis specific reactions in the basophilic cells, which in turn would augment the stimulating action of the hypophysis on the thyroid. The fact that we have found[8] that castrated animals are hypersensitive to thyroxin seems to establish a basis for this reasoning. Contrary to what happens in castrated animals, the injections of œstrogen or testosterone show an inhibiting action on the hypophysis, which could induce a state of hypothyroidism.

Thus we find that the thyroid influences the course of experimental tuberculosis; thyroxin increases the survival-rate, whereas thyroidectomy has an opposing action.

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[2] Bricker, F. M., *Z. Tuberk.*, **40**, 198 (1924).

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Cultivation of the Erythrocytic Form of *Plasmodium gallinaceum* in Tissue Cultures of Embryonic Chicken Brain

In previous experiments a method was found for the cultivation of the exoerythrocytic form of *Plasmodium gallinaceum* in tissue cultures of embryonic chicken brain. It was found that proliferation of the parasites in tissue culture cells is very slow, and that the initial stages are difficult to observe *in vivo* and also in the stained cultures. Parasites were still found after 134 days of cultivation in tissue cultures.

On account of the slowness of the proliferation and the difficulty of observing the initial stages of the parasite, we repeated experiments on the cultivation of the form of the parasite found in the blood, which formerly were carried out without result, perhaps because insufficient time was given and also because of inability to recognize the early stages in the cells.

We cultivated embryonic chicken brain together with a drop of highly infected chicken blood, first, for some time in Carrel flasks, and passing later to the hanging drop method. With this technique and the better knowledge of the initial stages of the parasites in the cells, we have observed parasitized cells after three or four weeks of cultivation. The parasites in these cultures had the same form as those in cultures of the exoerythrocytic form.

Details and colour photomicrographs of the infected cells will be presented in the complete publication of this work, which will be sent to *Revista Brasileira de Biologia*.

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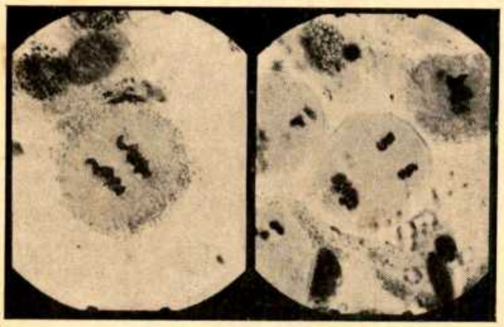
Chromosome Number and Behaviour in *Luzula purpurea* Link

IN the course of cytological investigations for the establishment of the chromosome atlas of the endemic flora of Portugal, we found in *Luzula purpurea* Link—a rare annual species only known from Portugal, Madeira and Canary Islands[1,2]—the diploid number $2n = 6$.

Besides their low number, the chromosomes of this species seem to be provided with two centromeres, one placed at each end of the chromosome. No median, sub-median or sub-terminal constriction could be distinguished either in mitotic or meiotic metaphases.

In anaphase figures both mitotic and meiotic the chromosomes take the shape of a **U** with their ends turned to the poles and not that of an inverted **V** as it normally occurs (see accompanying photographs).



This appears to be the first time such chromosome behaviour has been found in plants, and we think it may be related to what Toledo Piza[3] reported for the Brazilian scorpion *Tityus bayensis* Perty and for some Hemiptera[4]. Schrader[5], Hughes-Schrader and Ris[6], and Ris[7], working also with Hemiptera, found what they called "diffuse centromeres". This may be also the expression of a common behaviour.

A detailed description of the meiosis of *Luzula purpurea* will soon be published.

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Estaçao Agronómica Nacional,
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May 6.

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Mortality of *Aedes ægypti* Feeding on Rabbits Receiving Oral 'Gammexane'

LINDQUIST *et al.*[1] discovered the toxicity to bed bugs of the blood of rabbits fed on D.D.T., and de Meillon[2] has recently reported the action of 'Gammexane' in regard to mosquitoes. This communication describes a series of tests to elicit the minimum lethal dose of 'Gammexane' in similar circumstances, and the period during which the effect lasts.

The mosquitoes came from an *Aedes ægypti* colony, and were reared and stored in a constant-temperature room of 80°–85° F. in a humidity of 70 per cent. The tests were carried out in the same room; 72-hr. old unfed females were used. The 'Gammexane' was given in the form of a 5·5 per cent solution in rectified spirits, either in a capsule or more conveniently by pipette directly down the throat of the rabbit. Then, at different intervals, the mosquitoes were allowed to feed on the rabbits' ears, and those which fed were collected and stored in cages for 24 hr., when the dead were counted. Unfed specimens were discarded. Prior to the administration of the 'Gammexane', a control group of mosquitoes were fed on the animal, and the mortality was observed after 24 hr.

Two series of tests were conducted, the first to ascertain the minimum lethal dose during the first seven hours and at 24 hr., and the second to observe for how many days the insecticidal effect persisted. The results are shown in Tables 1 and 2 respectively.

TABLE 1. LETHAL ACTION OF 'GAMMEXANE' DURING FIRST 24 HR.

Dose of 'Gammexane'* (mgm. per kgm.)	Control		Hours after administration of 'Gammexane'				
	Number fed	Number alive after 24 hr.	1½	3	5	7	24
			Numbers fed and deaths after 24 hr.				
40	10	9	2:2	6:6	6:6	4:4	1:1
40	15	15	10:10	14:14	20:20	16:16	6:6
30	14	13	9:9	8:8	5:5	6:6	5:5
25	11	11	8:6	6:6	4:4	3:3	3:3
25	6	6	5:5	9:9	6:6	4:4	3:3
20	7	7	7:5	7:7	9:9	6:6	4:4
15	10	10	10:10	8:7	6:4	8:7	6:6
10	10	10	—	7:0	2:1	4:3	16:9

* 'Gammexane' = γ isomer.

TABLE 2. LETHAL ACTION OF 'GAMMEXANE' DURING WEEK AFTER ADMINISTRATION

Dose of 'Gammexane'* (mgm. per kgm.)	Control		Days after administration of 'Gammexane'					
	Number fed	Number alive after 24 hr.	1	2	3	4	5	6
			Numbers fed and deaths after 24 hr.					
40	9	9	—	6:6	7:7	8:8	16:3	10:0
30	8	8	10:10	15:15	9:9	8:0	5:0	—
25	12	12	5:5	5:5	13:5	3:0	4:0	—
25	11	11	3:3	4:4	2:2	2:1	—	3:0
15	10	10	6:6	5:5	—	—	—	—

* 'Gammexane' = γ isomer.

The minimum lethal insecticidal dose appeared to be between 25 and 30 mgm. of 'Gammexane' per kgm. of rabbit, though even dosages of 15 mgm. gave a partial mortality. The figures suggest that the concentration of 'Gammexane' in the blood rises for 24 hr.; thus, with the lower dosages, mosquito mortality is incomplete at first, whereas if the insects are fed later in the 24 hr. all may die.

The persistence of the lethal action after a single dose varies according to the amount of 'Gammexane' administered. The maximum period for a complete kill was four days following a dose of 40 mgm. With lower amounts, the effect lasted only two days. The lethal action disappeared rapidly at the conclusion of these periods of complete mortality.

The final reading of deaths was always taken after 24 hr.; as a rule, most of the mosquitoes were 'down' three hours after feeding.

It is doubtful if the dosage could be increased much beyond 40 mgm. per kgm., for even with that amount several of the rabbits died in convulsions.

The number of mosquitoes used in the tests was rather small, chiefly because the insects showed a reluctance to feed on an animal treated with 'Gammexane'. Very often 50 had to be used in order to get 10 to take enough blood for a test, whereas with a normal rabbit practically all would feed.

The amount of blood imbibed by an *Aedes ægypti* was determined by weighing specimens on a torsion balance before and after feeding. The average weight of 30 unfed 72-hr. old females was 2·04 mgm. (± 0·3 mgm.); after feeding on a rabbit treated with 'Gammexane' the weight was 4·56 mgm. (20 specimens), representing a gain of 2·52 mgm. of insecticidal blood. On a normal rabbit the mosquitoes gorge more fully, and the average gain of weight with them was 4·16 mgm.

These results rather indicate that, so far as *Aedes ægypti* mosquitoes are concerned, the method has little practical application; first, because the effect lasts only for four days, and secondly, because the mosquitoes apparently dislike feeding on an animal treated with 'Gammexane'. The action of the insecticide, however, is powerful and is 100 per cent effective while it lasts.

I have pleasure in thanking my assistant, Mr. J. C. Pyefinch, for much practical help in carrying out the tests.

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Frenkel's Views on the Origin of Terrestrial Magnetism

J. Frenkel has recently put forward[1] a theory of the origin of terrestrial magnetism that depends on the field being maintained by the electric currents induced in the liquid metallic core of the earth by the thermal convection of the material of the core.

Theories that ascribe the earth's magnetic field to motions in the core are attractive as, so far as is known, they provide the only possibility of explaining changes in times of the order of a century. Unfortunately, Frenkel's argument appears to contain faults which invalidate it.

Frenkel notes that free convection would occur in the core if the thermal gradient exceeded the adiabatic gradient, and shows that the rate of heat generation required (about 10^{-7} erg./cm.^{3}/sec.) is much below that produced by the radioactivity of surface rocks. However, the iron core model postulated is more appropriately to be compared in composition with iron meteorites than with surface rocks. Six iron meteorites analysed for uranium and thorium by Paneth[2] give an average heat generation of $4{\cdot}2 \times 10^{-8}$ erg./cm.^{3}/sec., which is not quite so much as Frenkel requires. This, however, is a minor point, as the theoretical value is subject to great uncertainty, and the experimental results are of doubtful relevance.

Frenkel assumes that the convective motion will be in paths of a size comparable with the radius of the core, and shows that if the viscosity is taken as 0·01 gm./cm.sec., velocities comparable with that of light will be generated. He concludes from this that viscosity is not able to control the convection currents and maintain reasonable velocities, and that the control must be by a dynamo action, of the kind suggested by Larmor. The system is supposed to approximate to an ideal thermodynamic engine for changing heat energy into electric currents. In fact, the Reynolds' number of the motion considered is about 10^6, and turbulent motion would certainly ensue, increasing the velocity gradients and enabling viscosity to control the motion. The viscosity assumed may well be too low, but if it is increased to obtain stability for the large-scale motion, the possibilities of energy dissipation in this motion will be increased. The hydrodynamic theory of a convecting core would repay detailed investigation.

No reference is made by Frenkel to Cowling's demonstration[3] that self-maintenance of a steady magnetic field by fluid motions with axial symmetry is impossible. Unless some way can be found of avoiding this theorem, all theories of the kind considered by Frenkel seem necessarily to fail in spite of their other attractions.

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[1] *C.R. Acad. Sci. URSS.*, **49**, 98 (1945).

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Relation Between the Intensity of Solar Radiation on 175 Mc./s. and 80 Mc./s.

In a previous communication[1] we described some experiments on electromagnetic radiation emitted from the sun on a frequency of 175 Mc./s. In the present note we give some results, obtained during the period December 1946–April 1947, of observations in which the same technique has been used to obtain simultaneous records of the intensity of solar radiation on the two frequencies of 175 Mc./s. and 80 Mc./s.

During periods of increased activity the radiation is characterized by the presence of short-lived 'bursts' of radiation having an intensity up to five times the mean value, and lasting from one to twenty seconds. An examination of the records shows that there is apparently no correlation between the times of occurrence of bursts of this type on the two frequencies. A section of a typical record is shown in Fig. 1. (The alteration of mean intensity recorded in this figure is due to the use of a pair of aerials as explained earlier[1].)

At times, however, very much larger bursts occur, having intensities as great as 20 or even 100 times

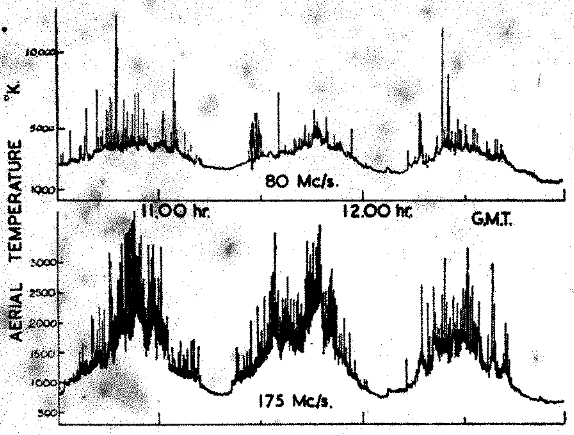

Fig. 1. SOLAR RADIATION, JANUARY 22, 1947

the mean value, and these may persist for many minutes. These larger bursts are usually observed on both frequencies, and many are accompanied by other evidence of solar activity, such as the observation of solar flares, or radio fade-outs.

The production of such short-lived bursts of high intensity is presumably due to a temporarily increased effective temperature of the source. The lack of coincidence between bursts observed on the two frequencies, therefore, suggests that radiation on these two frequencies originates in different regions, and that only during periods of great activity are both regions affected by the same sudden disturbance.

In addition to these short-lived bursts of radiation, the day-to-day variation of the intensity on the two frequencies has been investigated. The mean value during the four midday hours of each day has been plotted, for the period December 14–April 22, in Fig. 2. The intensities are expressed in terms of the equivalent temperature of a black-body source subtending an angle of ½°.

It can be seen that, while these curves show some evidence for variations with a period of 27 days (as would be expected from the movement of an active area across the sun's disk), there are other large-amplitude fluctuations of an apparently random nature.

In Fig. 3, the ratio of the equivalent temperatures of the source (T_{80}/T_{175}) has been plotted, and it is interesting to note that while the range of fluctuations is still of the order 4 : 1, it is considerably less than the range of fluctuations of the equivalent temperature on either frequency. This suggests that the day-to-day variations of intensity on the two frequencies are to some extent related.

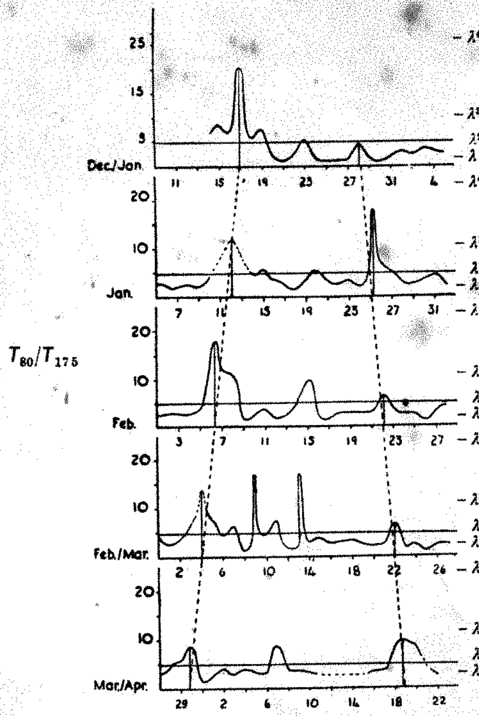

Fig. 3. RATIO OF EQUIVALENT SOURCE TEMPERATURES ON 80 MC./S. AND 175 MC./S. (T_{80}/T_{175})

It has been suggested by Appleton and Hey[2] that there is a definite wave-length – intensity distribution for the increased radiation emitted during periods of solar activity, and that observed departures from this distribution are the result of ionospheric influence. The results shown in Figs. 2 and 3 for frequencies of 175 Mc./s. and 80 Mc./s. (which cannot be affected appreciably by the ionosphere) indicate that whereas the general level is consistent with an equivalent temperature which varies as λ^2, there are marked departures from this relation on many days.

An examination of Fig. 3 shows that the occasions when the ratio of the intensities departs appreciably from the average tend to recur with a period of about 27 days, in a manner far more marked than the variations of intensity on either frequency alone. Our results, therefore, suggest that when the ratio of the intensities on the two frequencies assumes abnormal values, it is due to directed emission, the angular distribution of which is different for the two frequencies.

If the recurrence tendency detectable in Fig. 3 is substantiated by further measurements, it seems probable that the day-to-day variations of the intensity of solar radiation are partly due to directed emission with a 'polar diagram' which is a function of frequency, and partly due to variation of the effective temperature or the area of the source, which appears to be largely independent of frequency.

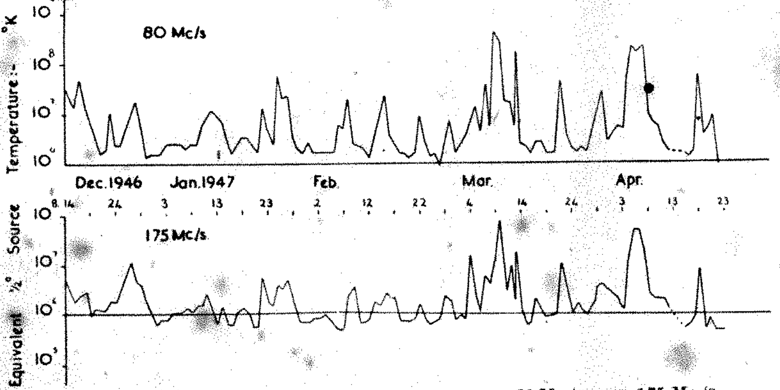

Fig. 2. DAY-TO-DAY VARIATION OF SOLAR RADIATION ON 80 MC./S. AND 175 MC./S.

The curve also suggests that there may be periodicities of 28, 27 and 26·3 days. These may be due to radiation from active regions at different solar latitudes.

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[1] Ryle and Vonberg, *Nature*, **158**, 339 (1946).

[2] Appleton and Hey, *Phil. Mag.*, **37**, 73 (1946).

Absorption Bands of Li_2, Na_2, K_2 and NaK

Although fairly complete information is available regarding the first two systems of bands of Li_2, Na_2 and K_2, the position with regard to the higher systems cannot yet be considered satisfactory. For this reason the spectra of these alkali-metal molecules, in the regions corresponding to the third, fourth and higher systems of bands, have been investigated in absorption, employing a quartz E_1 spectrograph for lithium, and a 21-ft. concave grating (Eagle mounting), having a dispersion of 1·3 A. per mm., for sodium and potassium. A hydrogen discharge tube has been used as source of continuum below λ 3600 and a tungsten lamp above that.

Li_2: The ultra-violet spectrum of Li_2 has been previously investigated by Vance and Huffman[1]. The bands lie between λ 3500 and λ 3100, and are regarded by them as belonging to four different systems. These, however, appear fragmentary. In the present investigation, the bands have been found to appear most satisfactorily at a temperature of about 1,000° C., using argon gas at a pressure of about half an atmosphere inside the absorption tube to prevent rapid distillation of the metal to cooler parts. Bands appear between λ 3900 and λ 3100, but the heads can be marked clearly only between λ 3500 and λ 3100. All the heads measured are found to belong to a single system represented by the equation:

$$\nu = 30658{\cdot}5 + 231{\cdot}5\,(v' + \tfrac{1}{2}) - 1{\cdot}5\,(v' + \tfrac{1}{2})^2 - 351{\cdot}6\,(v'' + \tfrac{1}{2}) + 2{\cdot}6\,(v'' + \tfrac{1}{2})^2.$$

The upper state of this system is considered to dissociate into 2 ^2S + 3 ^2P atoms. No evidence for other systems is found. The few additional band heads which led Vance and Huffman to conclude that as many as three more systems of bands exist in this region have not been observed in the present investigation. It is difficult to assign any definite reason for their measuring these band heads, as they have not published any value for the intensity of their bands. Another consideration which made them think that there was a case for several systems of bands of Li_2 in this region was analogy with the case of Na_2 which was formerly regarded as having three systems of bands in the corresponding region, namely, λ 3600–λ 3200. This, too, has been disproved, both in previous work[2] and in the present investigation. It seems, therefore, that the Li_2 bands between λ 3500 and λ 3100 really belong to a single system.

Na_2: The sodium molecule has bands in the ultra-violet region extending from about λ 3650 to about λ 2500, which are considered to belong to several systems[2]. Only the bands between λ 3600 and λ 3200 have been photographed in the present investigation for more accurate study. These bands appear well developed at a temperature of about 750° C., using nitrogen or some inert gas in the absorption tube at a pressure of about 5 cm. of mercury. The bands belong to a single system, and their heads can be represented by the equation

$$\nu = 29342{\cdot}0 + 119{\cdot}33\,(v' + \tfrac{1}{2}) - 0{\cdot}53\,(v' + \tfrac{1}{2})^3 - 159{\cdot}23\,(v''+\tfrac{1}{2})+0{\cdot}726\,(v''+\tfrac{1}{2})^2+0{\cdot}0027\,(v''+\tfrac{1}{2})^3.$$

The upper state of this system of bands is considered to dissociate into 3 ^2S + 4 ^2P atoms. The rotational structure of a few bands of this system has also been studied. This indicates that the bands have only two branches and are, therefore, due to $^1\Sigma_u^+ \leftarrow {}^1\Sigma_g^+$ transition. The values of B and r for the upper state are 0·1065 cm.$^{-1}$ and 3·70 A. respectively. It has not been possible to calculate the other constants such as D and α, for which higher dispersion would be necessary.

K_2: The K_2 molecule has been reported to possess bands in the blue and the ultra-violet region down to about λ 3,000[3-5]. Only the bands between λ 4520 and λ 3940 have been studied in the present investigation. The bands belong to two systems: (i) λ 4520–λ 4200; and (ii) λ 4160–λ 3940. The band heads of the first system can be represented by the equation

$$\nu = 22970{\cdot}0 + 60{\cdot}60\,(v' + \tfrac{1}{2}) - 0{\cdot}20\,(v' + \tfrac{1}{2})^3 - 92{\cdot}64\,(v'' + \tfrac{1}{2}) + 0{\cdot}354\,(v'' + \tfrac{1}{2})^2,$$

and its upper state is considered to dissociate into 4 ^2S + 5 ^2P atoms. The heads of the second system can be represented by

$$\nu = 24627{\cdot}7 + 61{\cdot}60\,(v' + \tfrac{1}{2}) - 0{\cdot}90\,(v' + \tfrac{1}{2})^2 + 0{\cdot}001\,(v' + \tfrac{1}{2})^3 - 0{\cdot}003\,(v' + \tfrac{1}{2})^4 - 92{\cdot}64\,(v'' + \tfrac{1}{2}) + 0{\cdot}354\,(v'' + \tfrac{1}{2})^2,$$

with its upper state dissociating into 4 ^2S + 4 ^2D atoms. The K_2 bands between λ 4160 and λ 3940 were previously considered to belong to two different systems[4]. It has been found that even the previous measurements which were attributed to two systems can be combined into a single system, if due allowance is made for some missing bands due to the broadening of the principal series doublet at λ 4045.

NaK: A system of NaK bands in the ultra-violet region between λ 4020 and λ 3540 has been reported by Walter and Barratt[6] and analysed in different ways by Weizel and Kulp[7] and by Uchida[8]. These bands have also been photographed in course of the present investigation on the 21-ft. grating. It has been found that only the bands between λ 4080 and λ 3820 are due to NaK, while the rest of the strong bands of Walter and Barratt which lie between λ 3660 and λ 3540 are due to Na_2. The band heads in the former region can be represented by the equation

$$\nu = 25201{\cdot}0 + 95{\cdot}85\,(v' + \tfrac{1}{2}) - 0{\cdot}94\,(v' + \tfrac{1}{2})^2 - 123{\cdot}29\,(v'' + \tfrac{1}{2}) + 0{\cdot}40\,(v'' + \tfrac{1}{2})^2.$$

The upper state of this system is considered to dissociate into Na 3 ^2S + K 4 ^2D atoms.

Full details will be communicated elsewhere.

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April 25.

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[2] Sinha, S. P., *Proc. Phys. Soc.*, in the press.

[3] Yamamoto, H., *Jap. J. Phys.*, **5**, 153 (1929).

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[6] Walter, J. M., and Barratt, S., *Proc. Roy. Soc.*, A, **119**, 257 (1928).

[7] Weizel, W., and Kulp, M., *Ann. Phys. Lpz.*, **4**, 971 (1930).

[8] Uchida, Y., *Jap. J. Phys.*, **5**, 145 (1929).

Spherical Electronic Waves ?

THE electronic A-waves which were predicted in a recent communication[1] were plane waves, and it is very difficult to picture them. It seems, moreover, that these would be indefinitely extended.

Consider the possibility, therefore, of a spherical wave of the form

$$\mathbf{A} = \frac{e\mathbf{v}'}{cr}\,\psi\left(t - \frac{\mathbf{s}}{\mathbf{u}}\right). \tag{1}$$

It will be noticed that the phase velocity is still $\mathbf{u} = c^2/\mathbf{v}$, but that outside the wave function ψ we have now included a factor similar to the known expression for **A** as excited by a point charge, $\mathbf{v}'$ being the velocity of the 'exciting' electron, **v**, **u** appertaining to the 'exploring' electron. We then find, proceeding as before, that

$$\nabla\mathbf{A} + \frac{\dot{\mathbf{A}}}{\mathbf{u}} = -\frac{ev'_r}{cr^2}\,\psi\left(t - \frac{\mathbf{s}}{\mathbf{u}}\right) + \frac{e\mathbf{f}'}{cr\mathbf{u}}\cdot\psi\left(t - \frac{\mathbf{s}}{\mathbf{u}}\right)\cdot\frac{dt'}{dt}, \tag{2}$$

where $\mathbf{f}'$ is $d\mathbf{v}'/dt'$. The condition that the left-hand side of (2) vanish is

$$\mathbf{f}' = \frac{\mathbf{u}v_r'}{r}\cdot\frac{dt}{dt'}. \tag{3}$$

This would be a very great acceleration, and we infer that (3) is not practicable. In the case $\mathbf{f}' = 0$ (uniform speed of exciting electrons) (2) may be written

$$\nabla\mathbf{A} + \frac{\dot{\mathbf{A}}}{\mathbf{u}} = -\frac{A_r}{r}. \tag{4}$$

The left-hand side may be replaced[1], giving

$$\frac{d}{dt}\left(\frac{m\mathbf{v}^2}{2} + e\varphi\right) = -\frac{A_r}{r}. \tag{5}$$

If A_r is positive (5) gives a decreasing total energy, which means radiation from the exploring electrons; very small, however, as we shall see.

Now when we take into account relativistic changes in mass[2], we require to replace $m\mathbf{v}^2/2$ by mc^2 in (5). For the first term of (5) would become

$$\mathbf{v}\,\frac{d}{dt}\,(m\mathbf{v}) = \mathbf{v}\,\frac{d}{dt}\left[\frac{m_0\mathbf{v}}{(1 - \mathbf{v}^2/c^2)^{1/2}}\right] = \frac{m_0\mathbf{v}\,d\mathbf{v}/dt}{(1 - \mathbf{v}^2/c^2)^{3/2}} = \frac{d}{dt}\,(mc^2); \tag{6}$$

when this is done (9) of the previous note becomes

$$m\mathbf{v}\dot{\mathbf{v}} + e\dot{\varphi}\,(1 - \mathbf{v}^2/c^2) = 0,$$

and this leads to

$$\dot{\mathbf{p}} = \frac{\mathbf{v}^2}{c^2}\,\dot{\mathbf{p}}_\mu \tag{7}$$

instead of to $\dot{\mathbf{p}} = 0$, where $\mathbf{p}_\mu = e\mathbf{A}/c$. Now from (1)

$$\dot{\mathbf{p}}_\mu{}' = \frac{e}{c}\,\dot{\mathbf{A}} = \frac{e^2}{c^2r}\,(\dot{\mathbf{v}}'\psi + \mathbf{v}'\dot{\psi}).$$

Thus

$$m\dot{\mathbf{v}} = \dot{\mathbf{p}} - \dot{\mathbf{p}}_\mu = \left(\frac{\mathbf{v}^2}{c^2} - 1\right)\dot{\mathbf{p}}_\mu = \left(\frac{\mathbf{v}^2}{c^2} - 1\right)\frac{e}{c}\dot{\mathbf{A}} = e^2\,\frac{(\mathbf{v}^2 - c^2)}{c^4r}\left(\dot{\mathbf{v}}'\psi + \mathbf{v}'\dot{\psi}\right). \tag{8}$$

For a stream of electrons all having substantially the same velocity, take $\mathbf{v}' = \mathbf{v}$.

$$\dot{\mathbf{v}}\left[1 + \frac{e^2}{mc^2r}\,\psi\cdot\left(1 - \frac{\mathbf{v}^2}{c^2}\right)\right] = \frac{-e^2}{mc^2r}\left[\left(1 - \frac{\mathbf{v}^2}{c^2}\right)\mathbf{v}\dot{\psi}\right]. \tag{9}$$

While solving the equation let us take $1 - \mathbf{v}^2/c^2$ as unity. We then obtain to the second order

$$\mathbf{v} = \bar{\mathbf{v}}/\left(1 + \frac{e^2}{mc^2r}\,\psi\right), \tag{10}$$

where $\bar{\mathbf{v}}$ is the non-wave-like uniform part of **v**. The component of **v** in the direction of r is obtained by replacing **v** by v_r, so that

$$\frac{A_r}{r} = \frac{e\bar{v}_r}{cr^2}\,\frac{\psi}{1 + \dfrac{e^2\psi}{mc^2r}} = \frac{e\bar{v}_r}{cr^2}\left(\psi - \frac{e^2}{mc^2r}\,\psi^2\right), \tag{11}$$

to the degree of accuracy to which we are working. In view of the minus sign in (5), (11) gives the rate of radiation of electromagnetic energy by the exploring electron (for slowly moving electrons).

The time average of this expression is

$$\left(\frac{\bar{A}_r}{r}\right) = -\frac{1}{2}\cdot\frac{ev_r}{cr^3}\cdot\frac{e^2}{mc^2}\,\psi\psi^*, \tag{12}$$

which is a third-order quantity, as one would expect of electromagnetic radiation. The rate of radiation as expressed by (12) differs from normal, however, in (at least) the following respects.

(*a*) It changes sign with e, being positive for electrons and negative for positrons or protons.

(*b*) It is a maximum if the radiating electron be moving in line with the point of observation.

(*c*) Its absolute value is insignificant except for values of r not greatly exceeding atomic dimensions.

In view of (*c*) any impairment in the energy of the beam would be too small to give rise to observable effects, except when the beam is brought into close contact with matter.

The main point of the present note is to establish that by extending the results of the previous communication to the physically more probable case of spherical waves, the loss of energy in the beam is insufficient to show on instruments, except when the beam is brought into close contact with matter.

The condition

$$d/dt\,(mc^2 + e\varphi) = 0 \tag{13}$$

is satisfied to a sufficient degree of approximation for the beam to appear of constant velocity when moving in a space substantially force-free. In particular, a cathode ray beam *in vacuo* would not be slowed down to a noticeable extent. We may, therefore, regard classical (Lorentz) electrodynamics as probably capable of explaining electronic waves, apart from assigning the phase of the wave, which involves Planck's constant.

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April 4.

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[1] *Nature*, **156**, 204 (1945).

[2] A. G. D. Watson, of A.S.E., in a letter to me dated Sept. 22, 1945, gave an alternative proof of (6).

Constitution of the Irradiation Product from Stilbamidine

FOLLOWING the observation by Fulton and Yorke[1] that the drug stilbamidine (4 : 4′-diamidinostilbene di-β-hydroxyethanesulphonate) undergoes photochemical change with production of a more toxic substance when its solutions are exposed to light, various investigators have put forward suggestions regarding the constitution of the irradiation product. Barber, Slack and Wien[2] reported that "The product is almost certainly 4 : 4′-diamidinophenylbenzyl carbinol, but rigorous proof is difficult". Goodwin[3], from spectrographic evidence, confirmed that saturation of the ethylenic linkage occurs, while Henry[4] reported that a number of chemical changes are involved, including dimerization.

On exposing a solution of stilbene in benzene for a long period to sunlight, Ciamician and Silber[5] isolated a hydrocarbon of m.p. 163° which from analysis and molecular weight determinations they considered to be a dimer of stilbene $C_{28}H_{24}$. This substance has been prepared in the present investigation by irradiating a similar solution with the light from a mercury vapour lamp, and has been used as a reference compound to show that the product of irradiation of stilbamidine is also a dimer, namely, 1 : 2 : 3 : 4-tetra-(4′-amidinophenyl)-*cyclo*butane. After irradiation of stilbamidine, the toxic product formed was isolated and purified as the sulphate. By hydrolysis with alcoholic potassium hydroxide it was converted to the corresponding tetra-acid which, on decarboxylation, gave the hydrocarbon m.p. 163° mentioned above, along with a small amount of another hydrocarbon of the same empirical composition and m.p. 149°.

The identity of the hydrocarbon m.p. 163° obtained by Ciamician and Silber with that obtained by decarboxylation of the tetra-acid was shown by the fact that both substances gave the same X-ray diffraction patterns. The second hydrocarbon m.p. 149° gave, on the other hand, quite different X-ray patterns. The X-ray data are as follows:

Melting point	163 °C.	149° C.
Crystal system	Monoclinic	Monoclinic
a, *A*	16·99 ± 0·10	20·45 ± 0·10
b, *A*	5·775 ± 0·02	9·40 ± 0·05
c, *A*	12·33 ± 0·08	10·77 ± 0·05
β°	127·0 ± 0·5	92·0 ± 1·0
Space group	P_{2_1}/a (C_{2h}^5)	P_{2_1}/n (C_{2h}^5)
Density (gm./c.c.) at 18° C.	1·23	1·14

For the hydrocarbon m.p. 163°, the observed density is consistent with the unit cell containing four asymmetric units $C_{14}H_{12}$; if these are grouped in pairs to form two molecules of $C_{28}H_{24}$, the resulting molecules must possess centres of symmetry. This is, in fact, the case, as has been shown by a fairly detailed X-ray analysis which shows that this substance is the centro-symmetric isomer of 1 : 2 : 3 : 4-tetraphenyl*cyclo*butane.

For the hydrocarbon m.p. 149°, the asymmetric crystal unit is the molecule, $C_{28}H_{24}$. This molecule may possess elements of symmetry, but these are not, as in the former compound, demanded crystallographically. We believe that this compound is the second isomer theoretically obtainable by dimerization of stilbene, namely, with a fourfold alternating axis of symmetry, but we have at present no evidence.

For the X-ray structure determination of the hydrocarbon $C_{28}H_{34}$ m.p. 163°, no direct analysis is possible, and trial methods were used in the preliminary stages. The method described by Robertson and White[6], involving the use of the small spacing planes with outstandingly strong spectra, gave an early approximation to the structure, which was then refined by three successive Fourier projections on (010) and a Fourier projection on (100). The final projection on (010) is shown in Fig. 1. While it is hoped to refine this analysis further by three-dimensional methods, certain interesting features of the structure are apparent at the present stage.

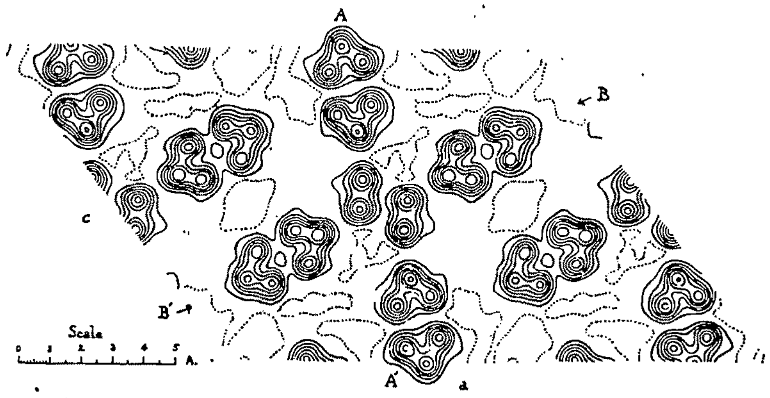

Fig. 1. THE CENTROSYMMETRIC ISOMER OF 1 : 2 : 3 : 4-TETRAPHENYL*cyclo*BUTANE. FOURIER PROJECTION ON (010), SHOWING ONE UNIT CELL

The projection on (010) (Fig. 1) shows clearly that the molecule is indeed 1 : 2 : 3 : 4-tetraphenyl*cyclo*butane; and the orientation of the phenyl groups about the central ring is diagrammatically shown in Fig. 2, where the benzene rings *A*,*A′*, *B*,*B′* are as indicated in Fig. 1.

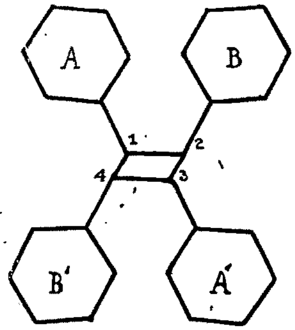

Fig. 2. DIAGRAMMATIC REPRESENTATION OF THE MOLECULE

The configuration about 1–2, 3–4 is *cis*-, while about 2–3, 1–4 it is *trans*-, and the different steric relationships of the phenyl groups about these bonds appear to be associated with considerable distortion of the cyclobutane ring. The ring is necessarily planar (owing to the presence of the centre of symmetry), but it is found to be rectangular rather than square. The observed dimensions are 1·63 A. for 1–2 and 2–3, 1·49 A. for 2–3 and 1–4, and 2·21 A. for the diagonals.

The value 1·63 A. is considerably larger than the normal carbon–carbon single-bond distance 1·54 A., but it is unlikely that it is subject to an error of more than 0·05 A. The other interatomic distances observed are approximately as expected; the benzene rings are found to be regular hexagons of side 1·39 A. (to within 0·03 A.), and the bonds connecting the benzene rings to the *cyclo*butane ring measure 1·52 A. At the present stage of the analysis, however, it would be virtually impossible to reconcile the data obtained with a square central ring.

In the second isomer, m.p. 149°, no distortion of the *cyclo*butane ring is expected to occur, but structure analysis has not so far been carried out for this substance.

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[1] Fulton, J. D., and Yorke, W., *Ann. Trop. Med. Parasitol.*, **36**, 134 (1942).

[2] Barber, H. J., Slack, R., and Wien, R., *Nature*, **151**, 107 (1943).

[3] Goodwin, T. W., *Ann. Trop. Med. Parasitol.*, **37**, 59 (1943).

[4] Henry, A. J., *Nature*, **152**, 690 (1943).

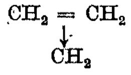
[5] Ciamician, G., and Silber, P., *Ber.*, **35**, 4128 (1902).

[6] Robertson, J. M., and White, J. G., *J. Chem. Soc.*, 607 (1945).

Formulæ for Ethylene Oxide and Cyclopropane

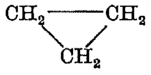
DR. A. D. WALSH[1] has misunderstood my criticism[2], which was not directed against his applications of wave mechanics but against the proposed symbols for ethylene oxide and cyclopropane and also against his statements relating to the reaction types of these substances. His further elaborations are of great intrinsic interest but irrelevant to the issues mentioned.

Dr. Walsh maintains that the hybridization of the three forms of (I) does not give (II):



$$\begin{array}{c} CH_2 = CH_2 \\ \downarrow \\ CH_2 \end{array}$$

(I)



(II)

That can only be justified by attributing to (II) some special significance in regard to the distribution of covalency electrons which is no part of the usual conventional meaning of the symbol. It will accommodate *any* such distribution of six covalency electrons which fulfils the requirements of symmetry. The formula represents only the mean position in space of the atoms (kernels) and the mode of binding (that is, the structure disclosed by analysis, synthesis, X-ray crystal evidence, etc.).

It is a further step to the space models which again concentrate attention on the atoms rather than on the distribution of valency electrons. We know that the environments of the carbon atoms in cyclopropane derivatives are tetrahedral (not, usually, *regular* tetrahedral), and this is true whether the valencies are trigonal or not. Incidentally, Dr. Walsh says that the atoms are *near*-trigonal, but that would appear to mean tetragonal, although of a very distorted type. The formula (II) is, therefore, entirely satisfactory unless we read more into it than was ever intended. On the other hand, (I) is unsatisfactory because its more important implications are lost on hybridization. It suggests that the carbon atom at the business-end of the arrow is negatively charged; this is not true of the hybrid. It suggests that this carbon atom makes no valency-electron contribution to the bond; again this is not true of the hybrid. It is obvious that any reaction-type implications of (I) are also lost on hybridization. Why should we adopt a formula, each unique feature of which is destroyed by mental reservations, or by the clumsy device of writing three symbols?

Dr. Walsh now finds that the wave-mechanical picture of ethylene oxide allows of *some* resemblance to acetaldehyde. I can only repeat that the chemical resemblance is very close indeed, that the analogy with ethylene is non-existent, and the parallel with amine-oxides is exiguous. The reaction encountered by Karrer[3] is readily explicable by reduction to a tertiary alcohol, a type of process that I mentioned previously[2]. In the presence of an acid catalyst such a substance would suffer dehydration with great facility, especially in these instances where the product is so fully conjugated. This example was naturally not mentioned by me because it is far from representative. If ordinary ethylene oxides were analogous to amine oxides, they should be convertible to ethylenes by mild reducing agents, and that is certainly not the case.

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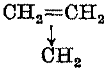
[1] Walsh, *Nature*, **159**, 712 (1947).

[2] Robinson, *Nature*, **159**, 400 (1947).

[3] Karrer, *Helv. Chim. Acta*, **28**, 474 (1945).

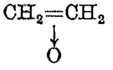
Structure of Ethylene Oxide and Cyclopropane

A. D. WALSH[1] has suggested that the properties of cyclopropane and ethylene oxide are better accounted for by the formulæ I (three equivalent resonance forms) and II than by III and IV:



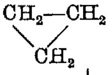
$$\begin{array}{c} CH_2{=}CH_2 \\ \downarrow \\ CH_2 \end{array}$$

I

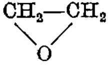


$$\begin{array}{c} CH_2{=}CH_2 \\ \downarrow \\ O \end{array}$$

II



III



IV

One consequence of this suggestion is that, in the CH-bonds, the carbon orbitals should be of the sp^2 hybrid type, rather than the sp^3 hybrid suggested by III and IV. In 1945 I obtained the force constants of a number of CH-bonds and found the following: methane, 4·97 (in the usual units); ethane, 4·81; ethylene (sp^2 bonds), 5·1 [2]. Fox and Martin[3] have suggested that in paraffins the CH-force constant is: CH_4, 5·04; CH_3 group, 4·75; CH_2 group, 4·56; CH group, 4·56. The force constant of the CH-link in cyclopropane and ethylene oxide might, therefore, prove valuable in deciding between the above structures.

From the Raman[4] and infra-red[5] spectra of cyclopropane it has been decided that the CH-valency vibration frequencies are: A_1', 3,000; E', 3,000; A_2'', 3,050; E'', 3,080 cm.$^{-1}$. The derived force constants are: 5·04, 5·04, 4·91 and 5·02. The mean is 5·0. (The same values of the fundamental constants have been used as in my previous paper[2].) The Raman[4] and infra-red[5] spectra of ethylene oxide indicate that the CH-valency vibration frequencies are A_1, 3,000; B_1, 3,000; B_2, 3,062; A_2, 3,062 cm.$^{-1}$. The derived force constants are 5·04, 5·04, 4·95 and 4·95. The mean is again 5·0. Ethylene sulphide is also of interest. Thompson and Dupré, having examined the Raman and infra-red spectra, suggested for the CH-valency vibrations: A_1, 2990; B_1, 2,990; A_2, 3,080; and B_2, 3,080 cm.$^{-1}$ [6]. The derived force constants are 5·00, 5·00, 5·02 and 5·02. The mean may be taken as 5·0. In all these three compounds the CH-force constant is 5·0.

For the CH-bond in a methylene group in an ordinary paraffin chain, we would expect the force constant to be about 4·6 (Fox and Martin), and certainly not greater than 4·8 (CH_3-group). The force constant in the methylene groups in these ring compounds is certainly significantly greater than this. It is, moreover, nearer the ethylene figure of 5·1 than to the figure for a methylene group in a paraffin. (It seems proper to make the comparison with the CH_2-group in a paraffin chain, though it may be noted that the CH-force constant in these ring compounds is not appreciably different from that in methane itself.) The conclusion to be made from these calculations must be that the force constants indicate that the CH-links in these ring compounds approach those in ethylene. So the calculations provide a measure of support for Walsh's suggestion. Of course, the CH-force constant might change simply as a result of the distortion in the angle between the bonds which form the ring. However, such a change is hypothetical, and it is, therefore, rather unsatisfactory as an explanation of these results.

The possible usefulness of the above calculations became apparent to me after hearing a lecture by Dr. Walsh on this and related topics.

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[1] Walsh, *Nature*, 159, 165 (1947).

[2] Linnett, *Trans. Farad. Soc.*, 41, 223 (1945).

[3] Fox and Martin, *Proc. Roy. Soc.*, A, 175, 208 (1940).

[4] Ananthakrishnan, *Proc. Ind. Acad. Sci.*, 4, 82 (1936).

[5] Linnett, *J. Chem. Phys.*, 6, 692 (1938).

[6] Thompson and Dupré, *Trans. Farad. Soc.*, 36, 805 (1940).

Fluorescence 'Fatigue'

Use of the term fluorescence 'fatigue'[1] to describe the decrease in fluorescence which is observed in many substances on continued irradiation, both in the solid state and in solution, is to be deprecated as it naturally implies something analogous to the well-known phenomenon of elastic fatigue; or to muscular fatigue. It is scarcely conceivable that any process at all comparable with either type of fatigue can occur in the case of a fluorescent molecule, particularly in dilute solution, and the only satisfactory explanation of any observed change of fluorescence with time of exposure to the exciting radiation, at any rate in dilute solution, is that photochemical changes occur which result in a change in the concentration of the molecular species responsible for the fluorescence. Recently published work[2] on the photochemical instability of stilbamidine made extensive use of the brilliant fluorescence of the *trans*-form of this compound to elucidate the nature of the photochemical changes which occur, and the above view is certainly amply justified in this case, the changes being concurrent dimerization and *trans*-*cis*-isomerization in proportions depending on concentration and temperature.

Neither *cis*-stilbamidine nor the product of the dimerization of *trans*-stilbamidine exhibits any fluorescence in the visible spectrum, but appropriate irradiation of solutions of these compounds results in a steady *increase* from zero in the intensity of fluorescence. This development of fluorescence on continued irradiation has been shown to be due, in each case, to partial conversion of the compound into *trans*-stilbamidine. The changes in fluorescence which solutions of these compounds exhibit on irradiation can therefore be explained completely in terms of the photochemical changes which occur. If the fading of the fluorescence of a solution of *trans*-stilbamidine on irradiation is to be attributed to a fluorescence 'fatigue', to what effect is the increase of the fluorescence of solutions of *cis*-stilbamidine and the dimer to be ascribed?

The change which the fluorescence of a solution of riboflavin undergoes on irradiation can also be quite adequately explained in terms of the photochemical changes which occur. This can be readily demonstrated by spotting-out the solution on filter-paper after varying periods of irradiation, washing radially[3] with water and examining the dry filter-papers in ultra-violet light. The steady disappearance of riboflavin from the solution, and the steady formation of a substance with a bluish fluorescence and greater adsorbability on filter-paper than that of riboflavin, which enables separation of the two compounds to be effected, is immediately apparent.

The importance in fluorimetric analysis of the dependence of fluorescence intensity upon time of irradiation is, of course, fully appreciated. The large effect on fluorescence which change of temperature sometimes produces must also not be overlooked. This is probably due in the main to modification of the course of some photochemical change which the fluorescent compound undergoes. Recovery of fluorescence on discontinuing irradiation can be attributed to reversal of a photochemical change taking place as a dark reaction.

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Sudan Medical Service,
Khartoum.
April 19.

[1] Alper, T., *Nature*, 158, 451 (1946).

[2] Henry, A. J., *J. Chem. Soc.*, 1156 (1946).

[3] Henry, A. J., and Grindley, D. N., *Ann. Trop. Med. Parasit.*, 39, 1 (1945).

The Name of Element 23

Prof. F. A. Paneth[1] has made certain suggestions in connexion with the naming of new elements. We quote the following: "(1) The right to name an element should go to the first to give definite proof of the existence of one of its isotopes. . . . (3) If a claim to such a discovery has been accepted in the past, but is refuted by later research, the name given should be deleted and replaced by one chosen by the real discoverer."

These rules seem to apply fittingly to the case of element 23, at present called vanadium, to which we wish to direct attention. The facts relating to its discovery, so far as known to us, are as follows:

In 1801 Andrés Manuel del Río, professor of mineralogy at the Royal School of Mines of Mexico, thought he had found in ores from Zimapán, Hidalgo, Mexico, a new element which he named 'erythronium'. He published his findings in "Tablas Mineralógicas" in 1804 [2]. In 1802 del Río gave samples containing the new element to Alexander von Humboldt, taking advantage of the latter's visit to Mexico[3]. Von Humboldt took these samples with him to Paris on his return to Europe and gave them to M. Collet-Descotils, asking for a report on del Río's claim. Collet-Descotils analysed del Río's samples and reported—erroneously—that they contained only chromium[4]. At that time von Humboldt accepted this verdict and therefore rejected del Río's claim as invalid.

The facts relating to Sefström's discovery of vanadium in 1830, and to Wöhler's work[5] establishing the identity of 'erythronium' and vanadium, are well known. Here we would only like to add that in 1831 both Berzelius[6] and von Humboldt[7] recognized del Río's priority as valid.

As a consequence of a conversation held between del Río and von Humboldt, the former gave up temporarily his claim to the discovery of a new element, accepting that what he had really found was chromium[8]. He held to this point of view after the publication of Collet-Descotils' error[9].

From the preceding historical facts, it follows that the real priority for the discovery of element 23 belongs to Andrés Manuel del Río. Our main purpose is to emphasize that under the rules suggested by Prof. Paneth, del Río's choice for the name of this element should stand. Element 23 should, therefore, be called 'erythronium' and not vanadium. Whether this change in accepted chemical nomenclature of long standing is at all possible is here neither implied nor suggested. Paneth's rules, however, either should be applied uniformly to all cases they are meant to cover, or to none at all.

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May 15.

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[1] Paneth, F. A., *Nature*, 159, 8 (1947).

[2] "Tablas Mineralógicas", by D. L. G. Karsten, translated into Spanish by Andrés Manuel del Río, footnote pp. 61–62, México, Zúñiga y Ontiveros, 1804.

[3] Letter addressed to Baron Alexander von Humboldt by Andrés M. del Río, dated October 14, 1817, published in *Mercurio de Espana*, p. 173, Madrid, February 1819.

[4] Collet-Descotils, M., *Annales de Chimie*, 53, 254–258 (1805).

[5] von Hoffmann, A. W., Briefwechsel zwischen J. von Liebig und F. Wöhler, *Kongl. Sv. Vetensch Acad.*, 1, 38–39 (1831); also *Poggendorfs Annalen der Physik und Chemie*, 21, 49 (1831).

[6] Berzelius, J., *Annalen der Physik und Chemie*, 22, 1–67 (1831).

[7] von Humboldt, A., Révue bibliographique pour servir de complément aux *Annales de Sciences Naturelles* par M. M. Audonin, Brongniart et Dumas, 2eme. année, pp. 42–43 (1831).

[8] *Anales de Ciencias Naturales*, 19, 31 (Madrid, Feb. 1804).

[9] *Diario de México*, 15, No. 2170, 294–295 (México, Sept. 11, 1811). *Mercurio de Espana*, 172–175 (Madrid, Feb. 1819). *Annalen der Physik von Gilbert*, 71, 7/12 (1822).

THE foregoing letter may create the impression that Del Río only "temporarily" abandoned his claim to the discovery of erythronium, misled by "Descotils' error" and Humboldt's persuasion. This, however, is not the story he himself tells in his last contribution to the subject[1]. In discussing the chemical composition of the Zimapan lead ore, he not only stresses the point that it contains no other element than the lead chromates, but ascribes to himself the merit of this 'discovery'. He states that he had published the correct analysis one year before Descotils, and attacks Humboldt for intentionally suppressing this fact and giving credit to a French chemist out of spite against the Spanish. Not a single word is said about the old erythronium claim, which he seems very anxious to consign to oblivion.

The rule suggested says that the right to name an element should go to the first to give *definite* proof of its existence. It is difficult to see how Del Río could be included under this heading, in view of his quick, complete and lasting change of front—even if we may have some doubts whether his recantation actually preceded the Paris analysis, as he so emphatically claims.

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[1] *Gilbert's Ann. der Phys.*, 71, 7 (1822).

Naming the Elements: a Former Suggested Use of 'Plutonium'

IN view of the recent naming of new elements, the following two quotations, which have lately come to my notice, may interest or amuse historians of science. They refer to an early *claim* that barium oxide can be reduced by the oxyhydrogen blowpipe. In Thomas Thomson's famous "System of Chemistry" (5th edit.; London, 1817), vol. 1, p. 342, we read: "Dr. Clarke has decomposed barytes by exposing it to an intense heat, produced by the combustion of a stream of oxygen and hydrogen gas, mixed together in the requisite proportions to form water. He has given to the metal of barytes the name of *plutonium*." It appears that, in this quotation, "barytes" means barium oxide and not the sulphate, as now (see below).

Edward Daniel Clarke (1769–1822) was, from the end of 1808 until his death, professor of mineralogy at Cambridge—he was the first occupant of the chair—and his life, travels and work are duly recorded in the "Dictionary of National Biography". Again, in the "Life and Remains of Edward Daniel Clarke" by the Rev. W. Otter (London, 1825), vol. 2, p. 455 (footnote), we read (Dr. Clarke speaking; date 1819): "In proposing the substitution of Plutonium, instead of Barium, for the name of the metal of Barytes, the author was actuated solely by a regard to truth, as essential to science. The impropriety of naming one of the lighter metals, from βαρὺς signifying *heavy*, will surely be obvious, when it now appears that the name implies an untruth. The specific gravity of the metal of Barytes equals 4·000. With what propriety, therefore, can it be denominated Barium, the heavy metal? . . . The metal of Barytes, in whatsoever manner its presence may be demonstrated, owes all the proofs of its existence to the dominion of fire; hence the propriety, at least, of giving to it the name of Plutonium.". Incidentally, the modern value for the specific gravity of metallic barium is 3·78.

In 1774, Scheele discovered a new earth in native manganese dioxide (which often contains barium as an impurity), and Gahn in 1775 found that this earth is a constituent of 'heavy spar' ($BaSO_4$). It seems that the *earth* was called 'barote' by Guyton de Morveau, 'barytes' by the Irish chemist, Kirwan, and 'baryta' by Lavoisier. Barium was isolated electrolytically by Davy in 1808.

As history would have it, Davy's name, 'barium', for the metal remained, in spite of Clarke's ingenuous logic; but we may now hail the unexpected return to the service of science of its former rejected rival.

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FULMER RESEARCH INSTITUTE

By E. A. G. LIDDIARD
(Director)

THE opening of the Fulmer Research Institute at Stoke Poges, Bucks, by Sir Stafford Cripps (see p. 150) marks the beginning of a new experiment in industrial research, the progress of which should be followed by all who are interested in the organisation of research in Great Britain. Briefly, the object of the Fulmer Research Institute, Ltd., is to provide research facilities which can be used to carry out research privately for any sponsor, or group of sponsors, the results arising from the research remaining under the control of the people who pay for the work. Its closest parallel is in the Battelle Memorial Institute or the Mellon Institute in the United States.

The suggestion has often been made, both in the editorial columns of *Nature* and elsewhere, that there is room in Great Britain for this type of research institute. This opinion is not invariably accepted, particularly by strong supporters of the research association movement, on the erroneous assumption that such an institute would compete with research associations. At the moment, fundamental research work in Britain is mainly carried out at the universities, and industrial research work either by the private laboratories associated with the works of individual firms or by research associations. Research associations have been particularly successful in solving problems which are common to all sections, and in educating industry in the scientific methods of approach to their problems. They also provide an excellent pool for the exchange of technical information which benefits the industry as a whole. The research associations have the advantage that the cost of researches is borne by many subscribers whose individual contributions are small in relation to the cost of the researches, and much more work can therefore be done than would be possible if the research work was left to be financed by the individuals concerned. The Department of Scientific and Industrial Research grant and the freedom they enjoy from rates and taxes put the research associations in a favourable financial position.

The limitation of a research association, however, lies in the absence of any mechanism for developing really new, original and individualistic ideas. The most advanced firms in any industry are not often prepared to put forward their very brightest ideas for the research association to work upon for the benefit of the whole industry. Research programmes of research associations are usually arranged on democratic lines by committees representing the industry, which restricts the activities of the research associations to problems in which the majority of the industry is interested but which are either beyond the resources of an individual member or are not considered to be sufficiently urgent or important to take up the time of the research department of individual members.

What, then, is the position of a concern wishing to develop an original idea or a new process of manufacture to help it to compete successfully in the world's markets ? In the absence of an institute where sponsored research is carried out confidentially, the choice lies between making the idea and the results of any research work on the idea generally known; when it becomes of equal value to competitors, or of collecting together the necessary specialized staff and equipment to do the work in its own laboratories. This entails considerable capital outlay, and, when the work is completed, the profitable use of the staff and equipment may present a difficult problem.

There remained, therefore, an important gap in our organisation of research, and in filling that gap there is no question of competition between an institute for sponsored research and a research association.

In the situation in which Great Britain finds itself to-day, we are told that we must export. Some of the most important assets of the country are the brains and ideas of its scientific workers ; these are at present mainly being used for the provision of knowledge which is available to the world at large. For pure scientific work this arrangement is ideal, but we are living in a competitive age, and it would seem to be common sense to do all we can to capitalize in the national interest our assets in the form of applied science. This can only be done effectively if the results of research remain in the hands of people capable of making full use of them. For example, a new process which may follow from research at a university becomes available equally all over the world, and is everybody's or nobody's property ; in fact, research work done in Great Britain has often been applied abroad before it is used at home. But where the results of research work are owned by an individual sponsor, any process arising from them can be used to increase our exports or, if patentable or negotiable, can result in increased national income from royalties, etc.

The Fulmer Research Institute aims eventually at carrying out research in a wider field, but to begin with, will concentrate on metallurgical and allied problems. Equipment and staff will be available to tackle most forms of metallurgical research, and work may be placed there in the knowledge that the results will be treated confidentially and that they may be exploited by the sponsor for his sole benefit. Provision has been made whereby nominees of the people who sponsor a research can come to work in the laboratories on the development of new industrial processes and can go back to the sponsor when the work is completed, carrying with them the knowledge that they have gained in the laboratories.

The idea of such an Institute was conceived by Colonel W. C. Devereux, who, having studied the system of sponsored researches in operation in the United States at the Battelle and Mellon Institutes, became convinced that a similar institution is needed in Great Britain. The Fulmer Institute is non-profit-making, in the sense that there will be no distribution of dividends. Charges for research are based on cost of salaries and materials, plus a small margin which will be available for the future expansion and further equipping of the Institute. Work is not undertaken on one problem for more than one sponsor unless the original sponsor agrees to share both the cost and the results of the research. Publication of the research results will be at the discretion of the sponsor ; but the Institute will advise publication wherever practicable, particularly where the results of the research can be covered by patents which, of course, become the property of the sponsor.

The size of the Institute can be assessed from the fact that the total floor area is approximately 20,000 sq. ft. Chemistry, corrosion, vacuum, engineering, physics and metallography sections are housed in the main building (a converted country mansion), together with the library, offices and canteen. A new building contains the machine shop and the experimental casting and heat-treatment laboratories. Twelve out of a total staff of forty are graduates, and the staff includes chemists, physical chemists, physicists and engineers as well as metallurgists.

The most important researches at present in progress are in the development of new alloys for service at high temperatures; researches on aluminium base alloys (these are in charge of Dr. A. H. Sully); and on a process for refining impure aluminium by catalytic distillation based on the existence of monohalides of aluminium stable at low pressures and high temperature which can be formed by passing the normal trivalent halides over aluminium at high temperatures and low pressures. They decompose to the metal and the trivalent halide at lower temperatures. This work is being carried out by a team under the direction of Dr. P. Gross. The principle is likely to be applicable to other metals, and sponsorship for researches on the refining of other metals on this principle is sought.

Although the Institute is prepared to consider any type of research work, the staff and equipment are such that problems in physical metallurgy, corrosion and finishing, the development of new casting processes and in the application of thermodynamics to metallurgical problems are likely to be tackled most successfully.

A certain proportion of short-term work involving mechanical and analytical testing and advice and information on technical problems is also undertaken and constitutes an important but not a major part of the Institute's activities.

SURFACE TENSION IN LIQUIDS

By C. GURNEY

THERE is ample experimental evidence that the free surface of liquids is in a state of tensile stress, but this stress has never been satisfactorily explained in terms of the positions and motions of molecules. It is generally recognized that liquids cannot permanently withstand shear, and yet a two-dimensional tensile stress implies shear in all planes inclined to the plane of the tension. How is this possible? The most acceptable previous explanation is that due to Bakker[1], which has recently been discussed by R. C. Brown[2]; but the Bakker theory is not very satisfying, as it is an attempt to show that the surface of a liquid could be in a state of effective tensile stress without an associated shear stress. The failure to explain the tension stress in the surface of liquids has led many writers to regard it as unreal. Authors who have referred to the stress as a 'fiction' include Laplace, Rayleigh and N. K. Adam. Adam[3] also writes, "The surface tension does not exist as a physical reality". J. Rice[4], in his commentary on Gibbs' papers on surface phenomena, is at pains to absolve Gibbs from having the notion that the surfaces of liquids are in a state of tension stress.

By giving a molecular interpretation to the thermodynamics of surfaces as developed by Gibbs, I give below what seems to be a satisfying explanation of the tension stress in the planes of surfaces, and which appears to have some novel features. Gibbs introduced into thermodynamics a quantity (μ) which he called the intrinsic potential of a substance. Subsequent authors have called this quantity partial molal free energy, chemical potential, etc. For equilibrium between phases and between each part of a heterogeneous phase, Gibbs showed that the intrinsic potential of the parts of each component substance must have the same value throughout the system. The intrinsic potential is a measure of the escaping tendency of molecules. Molecules tend to escape from regions of high μ and to migrate to regions of low μ. Equality of the intrinsic potentials ensures that just as many molecules of each species enter each region as leave it. This condition is therefore similar to the equation of continuity in fluid mechanics; but in thermodynamics we are dealing with random motion of molecules, whereas fluid mechanics deals with organised motion. At a given temperature, intrinsic potential depends on the arrangement and relative position of molecules. Molecules at a free surface or at an interface between two different substances have a different environment from interior molecules, and they would, therefore, be expected to have different intrinsic potentials, whereas for equilibrium they must have the same intrinsic potential as interior molecules. How then can equilibrium be achieved? At this stage it may be helpful to consider another case of thermal equilibrium.

Consider a pure substance, say lead, in equilibrium with its liquid. When stress-free, there is only one temperature at which this equilibrium can occur. At this temperature the intrinsic potentials of solid and liquid are equal. At room temperature, solid lead has the smaller μ, and in consequence the solid phase is stable. How could we have solid and liquid lead in equilibrium at room temperature? The answer is that stress must be applied to the solid or liquid or both, until their intrinsic potentials are equal. In principle at least we could apply pressure to the solid to increase its intrinsic potential to that of the stress-free liquid, or we could apply hydrostatic tension to the liquid to decrease its intrinsic potential to that of the stress-free solid. For two-phase equilibrium there is thus a relationship between stress and temperature. By making use of the relationships

$$\frac{\partial\mu}{\partial p_{Tn}} = \bar{v} \text{ and } \frac{\partial\mu}{\partial T_{pn}} = -\bar{s}, \quad . \quad . \quad (1)$$

(where p, T, and n are pressure, temperature, and quantity of substance respectively and $\bar{v}$ and $\bar{s}$ are specific volume and specific entropy), the relationship between p and T for the case in which the liquid only is subjected to pressure is

$$\frac{dp}{dT} = \frac{L}{T\bar{v}}, \quad . \quad . \quad . \quad (2)$$

where L is the latent heat of the solid-liquid transition. The equilibrium pressure on the liquid thus increases with temperature; at low temperatures (below the stress-free melting point) the equilibrium pressure is negative. In principle, therefore, we could have solid and liquid lead in equilibrium at room temperature by applying a hydrostatic tension to the liquid.

It is now only a small step to the explanation of the tension in the free surface of a liquid. In the absence of stress, surface molecules have a higher μ than interior molecules. For equilibrium, stress must be applied to the surface or interior or both, to make the intrinsic potentials of surface and interior molecules equal. As the surface molecules have the higher μ, it is easy to see, by analogy with the solid-liquid equilibrium case, that the stress which must be applied to maintain equilibrium is a tension in the plane of the surface. The thermodynamic relations are

$$\frac{\partial\mu}{\partial\gamma_{Tn}} = -\bar{A} \text{ and } \frac{\partial\mu}{\partial T_{\gamma n}} = -\bar{s}, \qquad (3)$$

where γ is the surface tension, $\bar{A}$ is specific area and $\bar{s}$ is the specific entropy of the surface. The relationship between surface tension and temperature is

$$\frac{\partial\gamma}{\partial T} = -\frac{L}{T\bar{A}}, \qquad (4)$$

where L is the latent heat of the liquid-surface transition. The difference in sign of expressions 2 and 4 is due to the fact that tension and pressure must be considered to be of opposite sign. The expressions are similar because the tension stress in the surface of a liquid is there for the same reason as would be the hydrostatic tension on a liquid in equilibrium with its solid, at a temperature below the stress-free melting point. The tensions are necessary to reduce the intrinsic potentials of the surface in the one case, and the liquid in the other, so that they equal the intrinsic potentials of the adjacent phases.

A more detailed picture of how the tension stress reduces the intrinsic potential of surface molecules may be obtained as follows. When a molecule escapes from the surface of a liquid, the neighbouring surface molecules move so as to fill up the hole which would otherwise be left by the escaping molecule. The area of the surface is thus reduced by the effective area of the escaping molecule. If acting in the plane of the surface, there is a constant tension force (γ); work must be done against this force which equals γA, where A is the effective area of a molecule. At the same time, the strain energy associated with the molecule is lost. This amounts to $\int_{A_0}^{A}\gamma dA$, where A and A_0 are the effective areas occupied by a molecule when the surface is under tension γ and zero force respectively. The net work done by the tension in the plane of the surface when a molecule escapes from the surface is therefore

$$-\gamma A + \int_{A_0}^{A}\gamma dA = -\int_{0}^{\gamma} A d\gamma. \qquad (5)$$

The right-hand side of this expression when differentiated and computed per unit mass instead of per molecule is equal to $-\bar{A}$, which by the first of equations (3) is equal to $\partial\mu/\partial\gamma$. The tension in the surface, therefore, reduces the intrinsic potential of the surface, because of the work done against the tension when a molecule escapes from the surface.

For substances in which the range of molecular action exceeds the effective dimensions of a molecule, the intrinsic potential of molecules near, but not actually in, the surface would exceed that of interior molecules, and some tension force (although it will be much smaller than that necessary between the outermost molecules) will be necessary to reduce their μ to that of interior molecules. The surface tension must thus be regarded as acting over a region a few molecules thick, the intensity of the force decreasing rapidly with increasing distance from the surface.

We are now in a position to discuss how the tension is set up and maintained. Imagine a stress-free surface of given area. The μ of surface molecules is higher than that of interior molecules. More molecules, therefore, leave the surface than enter it, so that fewer molecules are left to occupy the given area of surface. Their spacing in the plane of the surface therefore exceeds the stress-free spacing, and a tension stress is set up between them. Molecules continue to leave the surface until the tension stress is increased to that necessary to equalize the intrinsic potentials of surface and interior molecules. At this stress, equilibrium is attained, and just as many molecules enter the surface as leave it. The equilibrium tension is then automatically maintained. There is no need to postulate any special orientation of surface molecules or to try to show that there is no shear stress associated with the tension. The tension stress in the surface is continually trying to relax, but as fast as it does so the μ of surface molecules is increased, and then more molecules leave the surface than enter it until the surface is tightened up. If for any reason the tension became too high, the intrinsic potential of the surface would be too low, and more molecules would enter the surface than leave it, until the tension in the surface was slackened off. This is a fascinating process. In the plane of the surface of a liquid so mobile that millions of molecules per square centimetre are entering and leaving the surface per second, there exists a tension force which cannot relax.

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[1] Bakker, G., "Wien-Harms Handb. Exptphys.", 6 (1928).

[2] Brown, R. C., *Proc. Phys. Soc.*, in the press.

[3] Adam, N. K., "The Physics and Chemistry of Surfaces" (Oxford Univ. Press, 1941), 5.

[4] Rice, J., "Commentary on the Scientific Writing of J. W. Gibbs" (Yale Univ. Press), 1, 505.

INTRODUCTION OF NEW ELECTRICAL AND LIGHT UNITS

SIR CHARLES DARWIN, director of the National Physical Laboratory, has issued the following announcements with regard to the introduction of new electrical and light units, in accordance with the decisions taken by the International Committee of Weights and Measures at its meeting in Paris in October 1946.

Electrical Units

The system of electrical units employed at present at the National Physical Laboratory are the 'international' units, which are based on certain material standards. From January 1, 1948, the units employed will be those derived from the centimetre, gram and second, that is, the so-called 'absolute' units. The effects of this change may be seen from the following table:

1 international ohm = 1·00049 'absolute' ohms
" volt = 1·00034 " volts
" ampere = 0·99985 " ampere
" watt = 1·00019 " watts
" henry = 1·00049 " henries
" farad = 0·99951 " farad

The factors given in this table apply to the mean international units; that is to say, to the mean values of the international units as realized at the various national laboratories.

After January 1, 1948, apparatus submitted to the Laboratory with the view of the issue of a National Physical Laboratory Certificate of Examination will be regarded as acceptable if its errors fall within the specified limits when the values are expressed in either international or absolute units, provided that it was manufactured before January 1, 1949, and is marked accordingly. Apparatus manufactured after that date, and any apparatus not marked with the date of manufacture, will be acceptable only if its errors fall within the specified limits when the values are expressed in absolute units.

Unit of Light

The National Physical Laboratory will, on and after January 1, 1948, express all photometric values in terms of units based on the 'new candle'. This unit of luminous intensity is of such a magnitude that the brightness of a full (or cavity) radiator (black body) at the temperature of solidification of platinum is 60 'new candles' per square centimetre. The 'new lumen' is the luminous flux radiated within unit solid angle by a uniform source having a luminous intensity of one 'new candle'. The new unit of illumination will be one 'new lumen' per unit area. One 'new lumen' per sq. ft. will also be called one 'new foot-candle', and one 'new lumen' per sq. metre one 'new lux'. The new unit of brightness will be one 'new candle' per unit area, and, alternatively, one 'new foot-lambert'. The latter unit is defined as the brightness of a perfectly diffusing surface of 100 per cent reflexion factor when its illumination is one 'new lumen' per square foot.

When differences of colour are involved in the determination of any magnitude in terms of the above units, the evaluation will be in accordance with that which would be obtained by an observer having the relative luminosity curve (the curve connecting eye sensitivity with wave-length) adopted by the International Commission on Illumination in 1924 and later by the International Committee of Weights and Measures.

The differences between the new units and those in use hitherto are small. The present units, based on the 'international candle', were introduced on April 1, 1909, in Great Britain, France and the United States of America, and were adopted in 1921 by the International Commission on Illumination. Nevertheless, Germany and some Central European countries continued to use units based on the Hefner candle (about 0·9 international candle). The international candle was not based on any primary standard; it was derived from the units defined in terms of the old flame standards, and was maintained by means of carbon and tungsten filament electric lamps. Further, the values of the unit at different colour temperatures did not exactly agree, when compared on the basis of the international relative luminosity curve adopted in 1924.

The magnitude of the new unit has been so chosen that it will introduce only very small changes (less than 0·5 per cent) in the values of luminous intensity assigned to lamps operating at a colour temperature of about 2,360° K. For lamps at considerably higher colour temperatures, for example, ordinary gas-filled electric lamps at normal efficiencies, the values expressed in terms of the 'new candle' will be several per cent lower than those expressed in international candles. At the colour temperature of the primary standard (2,046° K.), values in terms of the 'new candle' are about 1·7 per cent higher than those in terms of the international candle.

On account of this alteration in the basis on which sources of light of different colours are compared, it is impossible to give a factor for converting values in international candles to values in 'new candles'.

U.S. NATIONAL ACADEMY OF SCIENCES

Elections and Awards

At the annual meeting of the U.S. National Academy of Sciences held in Washington during April 28–30, the following officers, members, and foreign associates were elected:

President (July 1, 1947–June 30, 1951): Alfred N. Richards, vice-president in charge of medical affairs, University of Pennsylvania (in succession to Dr. Frank B. Jewett).

Home Secretary (re-elected for a further term of four years ending June 30, 1951): F. E. Wright, Carnegie Institution of Washington, Washington, D.C.

Members of the Council of the Academy (for a three-year term ending June 30, 1950): W. Albert Noyes, jun., chairman, Department of Chemistry, University of Rochester, Rochester, N.Y.; and Donald D. Van Slyke, chief chemist, Hospital of the Rockefeller Institute for Medical Research, New York City.

Members: Luis W. Alvarez, professor of physics, University of California, Berkeley, California; Robert F. Bacher, U.S. Atomic Energy Commission, Washington, D.C.; Paul D. Bartlett, professor of chemistry, Harvard University, Cambridge, Mass.; Jacob Bjerknes, professor of physics, University of California at Los Angeles, California; Francis G. Blake, dean of Yale University School of Medicine, New Haven, Conn.; R. Alexander Brink, chairman of the Department of Genetics, University of Wisconsin, Madison, Wisconsin; Ralph W. Chaney, professor of paleobotany and curator of paleobotany, Museum of Paleobotany, University of California, Berkeley, California; Arthur C. Cope, professor in charge of the Department of Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts; Farrington Daniels, professor of physical chemistry, University of Wisconsin, Madison, Wisconsin; Arnold Gesell, director, Clinic of Child Development, Yale University School of Medicine, New Haven, Connecticut; James Gilluly, professor of geology, University of California at Los Angeles, California; R. B. Goldschmidt, professor of zoology, University of California, Berkeley, California; Samuel A. Goudsmit, professor of physics, Northwestern University, Evanston, Illinois; C. H. Herty, jun., research engineer and assistant to vice-president, Bethlehem Steel Company, Bethlehem, Pennsylvania; Frederick L. Hisaw, professor of zoology, Harvard University, Cambridge, Massachusetts; Wolfgang Köhler, professor of psychology, Swarthmore College, Pennsylvania; L. G. Longsworth, associate member, Rockefeller Institute for Medical Research, New York City; Edwin M. McMillan, professor of physics, University of California, Berkeley, California; Walter J. Meek, acting dean, Medical School, University of Wisconsin, Madison, Wisconsin; J. L. Oncley, director, Ultracentrifuge Laboratory, Harvard University Medical School, Boston, Massachusetts; Lars Onsager, professor of chemistry, Yale University, New Haven, Conn.; John P. Peters, professor of medicine, Yale University, New Haven, Conn.; Paul A. Smith, professor of mathematics, Columbia University, New York City; C. Richard Soderberg, professor of applied mechanics, Massachusetts Institute of Technology, Cambridge, Massachusetts; Paul Weiss, professor of zoology, University of

Chicago, Chicago, Illinois; F. W. Went, professor of plant pathology, California Institute of Technology, Pasadena, California; Robert E. Wilson, chairman of Board of Directors, Standard Oil Company of Indiana, Chicago, Illinois; E. Bright Wilson, jun., professor of chemistry, Harvard University, Cambridge, Massachusetts.

Foreign Associates: P. A. Alexandroff, professor of mathematics, University of Moscow; K. Linderstrøm-Lang, head of the Chemical Division, Carlsberg Laboratory, Copenhagen; J. N. Brønsted, professor and director of the Institute for Physical Chemistry, Copenhagen; Björn Helland-Hansen, director of the Geophysical Institute, Bergen; F. C. Bartlett, director of the Psychological Laboratory and professor of experimental psychology, University of Cambridge.

Medal Awards

John J. Carty Medal. The John J. Carty Gold Medal and Award for 1947 was presented to Dr. Ross G. Harrison, professor emeritus, Osborn Zoological Laboratory, Yale University, New Haven, Connecticut, for the discovery that tissue cells can be grown outside the animal body, and by the use of this discovery demonstrating the manner of growth of nerve fibres, a fundamental contribution to scientific medicine and biology; for long and distinguished service as investigator, teacher, and counsellor of students; and for statesmanlike direction of the National Research Council during a period in which it played a vital part in the defence of the United States. As a young man at Johns Hopkins he obtained striking experimental results while engaged in the study of the development of the nervous system. Here he first used the method of isolation of embryonic tissues in culture media and gave an ocular demonstration that the nerve fibre grows out from a single cell without the participation of accessory cells. This led to the procedure known as tissue culture, which has since been widely used in the study of the differentiation, growth and behaviour of normal and tumour cells under various conditions outside the body. After retirement from active university work in 1938 Dr. Harrison became chairman of the National Research Council, which post he held until June 30, 1946. The Council has grown in esteem under his leadership, not as an organisational instrument merely, but also as a place where men gather in friendly association to advance common interests.

Provision for the Carty Medal and Award was made by the American Telephone and Telegraph Company in honour of the late John J. Carty, a member of the Academy, as a token of esteem on the occasion of his retirement from active service. Under the terms of the deed of establishment, the award can be made not more often than once in two years. It can be conferred on anyone who in the judgment of the National Academy of Sciences has made noteworthy contributions to the advancement of fundamental or applied science in any field.

Daniel Giraud Elliot Medal. The Daniel Giraud Elliot Medal for 1945 has been awarded to Dr. Sewall Wright, Department of Zoology, University of Chicago, for his fundamental work dealing with the genetics of evolutionary processes; a programme based on work over a long period, including his paper, "The Differential Equation of the Distribution of Gene Frequencies" (*Proc. Nat. Acad. Sci.*, 31, No. 12; 1945).

Public Welfare Medal. The Public Welfare Medal of the Marcellus Hartley Fund for 1947 has been awarded to Dr. Karl T. Compton, president of Massachusetts Institute of Technology, Cambridge, Massachusetts, for eminence in the application of science to the public welfare, in recognition of his distinguished contributions of an original character to the science of physics, of his long and valuable career in the field of education and of university administration, and of his great service to the Government of the United States both before and during the War as a member of the National Defense Research Committee and as director of the Office of Field Service of the Office of Scientific Research and Development. "It is the purpose of the Public Welfare Medal to mark the appreciation of the National Academy for eminent services to the public, performed without a view to great monetary gains and by methods which in the opinion of the Academy are truly scientific."

Agassiz Medal. The Agassiz Medal of the Murray Fund for the year 1947 was awarded to Felix Andries Vening Meinesz, professor of geodesy and geophysics in the University of Utrecht and president of the Netherlands Geodetic Commission.

Because of the instability of the water-soaked ground in the Netherlands it was not possible to make accurate measurements of gravity there with the older types of instruments. In order to overcome the difficulty Vening Meinesz designed his multiple-pendulum apparatus by which the desired measurements could be made on unstable ground. Prior to this invention attempts had been made to measure gravity at sea, notably by Hecker, but the results had errors ten times greater than was permissible in measurements made on land. As Vening Meinesz's apparatus could be used on a submarine it made possible gravimetric surveys of the different oceans. In 1923, with the help of the Netherlands navy, Vening Meinesz made his first long voyage, going from a home port to the Netherlands East Indies by way of Suez. In subsequent years he made many voyages in the Atlantic, Pacific, and Indian oceans, paying particular attention to the Mid-Atlantic Ridge and the West and East Indian island arcs. By the beginning of the Second World War, 844 observations had been made on Netherlands submarines, and many observations had been made on submarines of other countries. Among the interesting results of the gravimetric surveys was the discovery of strips of ocean bottom with negative anomalies, which in both the East and West Indies coincide with the seismic belts and the deep narrow troughs of those regions. The Mid-Atlantic Ridge is fundamentally different from the great island arcs in that in it there are no strips with negative anomalies. Two other generalizations are that fields of positive anomalies usually coincide with deep basins, and that the anomaly increases positively in going from shallow to deep water off both continental and island coasts.

Besides having made the measurements indicated above and having studied their distribution with reference to relief, seismic, and volcanic features, Vening Meinesz has proposed explanations of the processes operative in the formation of the troughs with the negative anomalies and the faults and folds in adjacent areas, a hypothesis for the explanation of the origin of the continents and ocean basins, and a hypothetical explanation of a postulated rotation of the earth's crust over deeper-seated material. The value of these unique researches in the study of the physical features of the ocean bottom and adjacent land areas is beyond estimate.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Teacher in the Mathematics and Physics Department—The Principal, Municipal Technical College, Hopwood Lane, Halifax (August 9).

Topographical Surveyors (4), Geologists (2), Biologists (2), and a Physicist, to the Falklands Islands Dependencies Survey—The Under-Secretary for the Colonies, Room 2, 3rd Floor, Queen Anne's Chambers, Dean Farrar Street, London, S.W.1 (August 9).

Graduate Assistant in the Department of Biochemistry—The Administrator, A.G.E. Sanctuary, Radcliffe Infirmary, Oxford (August 9).

Senior Principal Scientific Officer (with an Honours Degree, preferably in Mechanical Engineering), and a Principal Scientific Officer (with high Honours Degree in Physics), in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1941 (August 11).

Lecturer in Flight Experiments in the Department of Flight—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks (August 11).

Psychologist—The Director of Education, Education Offices, Cobourg Street, Plymouth (August 11).

Technical Chemist, and a Bacteriologist—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (August 15).

Assistant Lecturer in Physics—The Registrar, The University, Leeds 2 (August 15).

Assistant Lecturer in Mycology—The Registrar, The University, Manchester (August 16).

Lecturer in Crop Husbandry in the Department of Agriculture—The Secretary, The University, Edinburgh (August 17).

Senior Lecturer (Grade I) in Chemical Engineering, a Lecturer (Grade II) in Petroleum Production, and an Assistant Lecturer (Grade III) in Botany—The Secretary, The University, Edmund Street, Birmingham 3 (August 18).

Lecturer (temporary) in the Department of Electrical Engineering, University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 21).

Meteorological Officer Cadets (15) in the Department of Industry and Commerce—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (August 22).

Research Officer (Physical Chemist), Section of Tribophysics, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1314 (August 23).

Research Officer, Aerodynamics Section, Division of Aeronautics, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1319 (August 25).

Veterinary Inspectors (about 100) and Research Officers and Assistant Veterinary Investigation Officers (40)—The Secretary, Ministry of Agriculture and Fisheries, 23–25 Soho Square, London, W.1 (August 31).

Demonstrator in Anatomy, a Demonstrator in Physiology, a Demonstrator in Morbid Anatomy and Morbid Histology, a Lecturer in Anatomy, a Lecturer in Physiology, and a Lecturer in Biochemistry—The Secretary, Charing Cross Hospital Medical College, 62 Chandos Place, London, W.C.2 (August 31).

Technicians in the Departments of Anatomy and Physiology—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2 (August 31).

Principal Scientific Officer in the Intelligence Division of the Headquarters Office of the Department of Scientific and Industrial Research in London—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1951 (September 1).

Horticultural Officer, and an Assistant Horticultural Officer—The Chief Education Officer (A), Shire Hall, Cambridge (September 12).

Lecturer in Applied Chemistry, with qualifications to teach students taking an Honours Degree in Technical Chemistry—The Secretary, The University, Edinburgh (September 15).

Professor of Humanity in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 15).

Graduate (in metallurgy, chemistry or physics) for work in a laboratory in the London area in connexion with the production of pure iron and associated research—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'London'.

Soil Technologist and Soil Chemist for the Directorate-General of Agriculture, Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.14628.

Lecturer in the Department of Physiology—The Secretary, The University, Aberdeen.

Workshop Mechanic in the Department of Physics—The Professor of Physics, Queen's University, Belfast.

Lecturer in the Mathematics Department—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Scientific Assistants (with honours degree in agriculture, botany, geography or biochemistry)—The Director, Imperial Bureau of Pastures and Field Crops, Penglais, Aberystwyth.

Laboratory Assistant with experience of histological technique—The Professor of Physiology, The University, Bristol 8.

Photographer for medical and scientific work—The Secretary, Physiology Department, School of Medicine, Leeds 2.

Bacteriologist for provincial diagnostic laboratory of public health in Halifax, Nova Scotia—Dr. E. G. Young, Lister Institute, Chelsea Bridge Road, London, S.W.1.

Assistant Experimental Officers (Chemists, male) in the Plant and Animal Products Department—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

Chair of Bacteriology in King Edward VII College of Medicine, Singapore—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Experts in (*a*) Preparation of Vaccines (M.N.18172), (*b*) Bacteriology (M.N.18173), (*c*) Animal Husbandry (M.N.18174), in the Veterinary Department, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting appropriate Ref. No.

Assistant Lecturer in Logic and Scientific Method—The Secretary, London School of Economics, Houghton Street, London, W.C.2.

University Assistantship in the Department of Biochemistry—The Secretary, The University, Edinburgh.

Laboratory Steward in the Chemistry Laboratories, and a Laboratory Steward in the Biology Laboratories—The Principal, County Technical College, Stoke Park, Guildford, Surrey.

Inspectors of Mines in Tanganyika Territory—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Professor of Pathology tenable at King's College, Newcastle-upon-Tyne—The Registrar, University of Durham, 46 North Bailey, Durham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Annual Report on the Progress of Rubber Technology. Edited by Dr. T. J. Drakeley. (Published for the Institution of the Rubber Industry.) Vol. 9, 1945. Pp. vi + 117. (Cambridge: W. Heffer and Sons, Ltd., 1946.) To Members, 4*s*. 6*d*. net; to non-Members, 12*s*. 6*d*. net. [32

University of Cambridge. Annual Report of the Observatories Syndicate. Pp. 4. (Cambridge: The University, 1946.) [32

Parliamentary and Scientific Committee. Annual Report, 1946. Pp. 18. Universities and the Increase of Scientific Manpower. Pp. 22. 1*s*. (London: Parliamentary and Scientific Committee, 1946–1947.) [32

British Standard 1339: 1946. Humidity of the Air: Definitions, Formulae and Constants. Pp. 10. (London: British Standards Institution, 1946.) 2*s*. net. [42

Department of Scientific and Industrial Research: Fuel Research. Technical Paper No. 54: The Reduction of Smoke from Merchant Ships; Trials carried out in S.S. *Ocean Vista*, to determine the Effect of Smoke Elimination upon Fuel Consumption. Pp. vi + 39 + 5 plates. (London: H.M. Stationery Office, 1947.) 1*s*. 3*d*. net. [42

'Wellcome' Photographic Year Book, 1947. Pp. 100 + Diary. (London: Burroughs Wellcome and Co., 1947.) 3*s*. 5½*d*. [42

The Profession of Naval Architect. Pp. 8. (London: Institution of Naval Architects, 1947.) [62

Broadcasting Stations of the World. Compiled by *Wireless World*. Pp. 48. (London: Iliffe and Sons, Ltd., 1946.) 1*s*. net. [62

University of London: University College. Calendar, Session 1946–1947. Pp. lxii + 374. (London: Taylor and Francis, Ltd., 1946.) [62

Other Countries

South African Archaeological Society. Handbook Series No. 2: The Loom of Prehistory. By A. J. H. Goodwin. Pp. 152. (Cape Town: South African Archaeological Society, 1946.) Paper, 12*s*. 6*d*.; cloth, 15*s*. [301

Koninklijk Nederlandsch Meteorologisch Instituut. No. 108, Seismische Registrierungen in De Bilt. 25,1937. Pp. viii + 45. 0.80 fl. 26,1938. Pp. viii + 64. 1 fl. 27,1939. Pp. vii + 25. 1 fl. 28,1940. Pp. ix + 31. 1 fl. 29,1941. Pp. vii + 34. 1 fl. ('s-Gravenhage: Koninklijk Nederlandsch Meteorologisch Instituut, 1939–1943.) [301

Koninklijk Nederlandsch Meteorologisch Instituut. No. 111, Opstellen op Oceanografisch en Maritiem-Meteorologisch Gebied. 3^{III}, Passaten, Moessons, Enz. Pp. 56. 0.40 fl. 3^{IV}, Koers en gisvaart voor Stroomberekening. Pp. 23. 0.30 fl. 5, Over de fouten bij een Kwikbarometer met vernauwde buis, Indien de Luchtdrukking verandering Ondergaat. Door H. Keyser. Pp. 16. 0.20 fl. ('s-Gravenhage: Koninklijk Nederlandsch Meteorologisch Instituut, 1939–1940.) [301

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106a, Ergebnisse Aerologischer Beobachtungen. 27,1938. Pp. iv + 46. 1.50 fl. 28,1939. Pp. iv + 36. 1.50 fl. 29,1940. Pp. iv + 12. 1.50 fl. ('s-Gravenhage: Koninklijk Nederlandsch Meteorologisch Instituut, 1939–1941.) [301

Koninklijk Nederlandsch Meteorologisch Instituut. No. 119: Statistics relating to Typhoons from about 3300 Netherlands Ships' Observations (1910–1935). Vol. 1: Text. Pp. 100. 3.50 fl. Vol. 2: Illustrations. Pp. iv + 54 plates. 3.50 fl. ('s-Gravenhage: Koninklijk Nederlandsch Meteorologisch Instituut, 1939.) [301

Southern Rhodesia. Geological Survey Bulletin No. 37: The Geology of the Lower Gwelo Gold Belt. By Dr. F. L. Amm. Pp. vii + 76 + 5 plates. (Salisbury: Government Stationery Office, 1946.) 3*s*. 3*d*. [42

Annual Report of the Board of Regents of the Smithsonian Institution showing the Operations, Expenditures and Condition of the Institution for the Year ended June 30, 1945. (Publication 3817.) Pp. iv + 484 + 80 plates (Washington, D.C.: Government Printing Office, 1946.) 1.75 dollars. [42

Indian Council of Agricultural Research, Statistical Branch, New Delhi. Functions and Activities. Pp. ii + 17 + 3 plates. (New Delhi: Indian Council of Agricultural Research, 1947.) [62

New Zealand Air Department. Meteorological Observations for 1942. Pp. 62. (Wellington: Government Printer, 1946.) [62

Observatoire de Paris, Section d'Astrophysique, à Meudon. Annales, Tome 8, Fascicule 3: Réduction de la Göttinger Aktinometrie au Système International et Indices de couleur de 3294 étoiles entre 0° et + 20° de déclinaison. Par Ch. Bertaud. Pp. iii + 40. Annales, Tome 10, Fascicule 1: Recherches sur Nova Herculis 1934 et contribution à l'étude comparative des principales novae. Par Charles Bertaud. Pp. iii + 234 + 6 plates. Cartes synoptiques de la chromosphère solaire et Catalogue des filaments de la couche supérieure. Par L. d'Azambuja et R. Servajean. Pp. 32. (Meudon: Observatoire de Paris, 1939–1945.) [62

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BRITISH COLONIAL DEVELOPMENT

THE announcement by Mr. Creech Jones in the House of Commons on June 25 of the Government's proposal to establish a Colonial Development Corporation marks a definite stage towards the establishment of a new Colonial system aimed at raising the standard of living in British Colonies, which has been implicit in such recent proposals as Dr. E. B. Worthington's Development Plan for Uganda, and the plan for the production of groundnuts in East Africa. The Ground-nut Corporation scheme is concerned primarily with foodstuffs; but its contribution to the raising of the standard of living in Tanganyika, Northern Rhodesia and Kenya may well far outshadow its contribution towards meeting the world shortage of fats. The twenty-five million pounds required for this Corporation is indeed to be provided separately; but it will none the less be as distinct a contribution to Colonial welfare as the capital of £100,000,000 of the Colonial Development Corporation now announced.

Mr. Creech Jones said that the Corporation would operate on commercial principles, and that its object would be to establish or assist any enterprise in the Colonies which is designed to increase their general productive capacity. While these enterprises might be mainly agricultural, the Corporation would be able to undertake any enterprise which served the general object either itself, or through subsidiary organisations for individual projects, or by assisting existing enterprises. Unlike the Development Board for the Colonies canvassed unofficially a few years ago, the new Corporation will be subordinate both to the Colonial Office and the Colonial Governments. The intention is that the Corporation and its subsidiaries should operate generally in close consultation with Colonial Governments, to ensure that their activities are conducted in the way best suited to promote the welfare of the Colonial peoples.

It was made clear that the Corporation is intended to supplement, not supplant, private enterprise. The Government would continue its policy of encouraging public utilities and other suitable forms of public enterprise; but it would also welcome private enterprise and investment so long as they are in harmony with the plans of Colonial Governments for social and economic development. Mr. Creech Jones, in reply to questions, indicated that the Government is alive to the importance of decentralization, and that although the head office must be in London, certain concerns and enterprises would have their principal offices in the territories with which they are strictly concerned.

The scheme as outlined by Mr. Creech Jones is thus based on the realization that capital on a far larger scale than is made available under the Colonial Development and Welfare Act is needed to raise the standard of living in the British Colonial Empire. What is equally important, there appears to be visualized co-operation with other Government departments besides the Colonial Office, such as the Board of Trade and the Ministry of Food. Several Departments are in fact already working together on a survey of opportunities for new commodity production in the Colonial Empire. Success may largely depend on the extent to which there is stimulated on a much larger scale that two-way flow of ideas, already to be seen on a modest scale, resulting from the work of the Colonial Research Committee and the Colonial Products Research Council. It will certainly depend largely on the extent to which there is secured the co-operation of scientific workers in the way that is so conspicuously a feature both of the ground-nuts project for East Africa and the development plan advanced by Dr. E. B. Worthington for Uganda*. The feature of Dr. Worthington's plan is the suggestion that pilot development schemes should be used to try out ideas of land use and social services which later can be applied to large parts of the Protectorate. They should also be areas of intensive production, at first by State enterprise, in country which is at present largely undeveloped. In this way, Dr. Worthington contends, about twice as much expenditure on public services per head of population as is possible in the country as a whole will pay dividends after ten years.

Dr. Worthington recognizes and states the fundamental problem in Colonial development and welfare which the general schemes under the new Corporation will equally have to face. The average standard of living cannot rise and public services cannot expand unless production increases at a greater rate than population. Ten years, he suggests, should be devoted to a production drive while increasing social services at a rate greater than population increase. If success is achieved, Uganda will be able to support mass education and a mass health scheme during the following decennium.

In the production drive, the great asset of Uganda is not man-power but undeveloped land and water. The chief factors which limit development are the lack of fundamental formation about the country and the people ; a system of production incompatible with the full use of natural resources ; lack of capacity of the African for physical work ; and power based on the most inefficient of fuels. Dr. Worthington's plan aims at solving the fundamental problem of balance between population and production by reducing these limiting factors, although he is doubtful whether adequate results can be achieved without some degree of compulsion, possibly the equivalent of that which is applied in Britain to-day.

The pilot schemes suggested are for the development of a self-contained piece of land, preferably a catchment area of say 500 square miles, sparsely inhabited on account of tsetse fly. Settlers up to 6,000 families would be employed for the first few years, while the whole area was being developed as a Government estate. At this stage there would be only six Europeans as against 42 Europeans to about 1,800 Africans in the resident units of the ground-nut scheme. Later, most of the settlers would become tenant farmers under close supervision, a part of the unit being retained as a Government farm. Initial clearing and subsequent cultivation would be undertaken with mechanical assistance, where possible. Communications, forestry, water-control, agriculture, fisheries and social services would be organised for the efficient development of land, water and people, with an emphasis on productive services.

The scheme is finely conceived and represents a scientific approach that might well be adopted more widely. It is not only in research in applied biology, in animal husbandry, forestry, fisheries, hydrology, meteorology, agriculture and the like that science can contribute so much to Colonial development and welfare. It is becoming more and more clear that the scientific approach is the only one that holds out real hope of a solution to the all-important human problem. Although Dr. Worthington makes like reference to the contribution of the social sciences, his scheme, like the ground-nut scheme, is in keeping with the idea that Mr. Aldous Huxley outlines in his recent book, "Science, Liberty and Peace"*, of developing regional self-sufficiency as a decentralizing and stabilizing factor in world order. It is equally in line with ideas which Col. W. R. Crocker emphasizes in his penetrating commentary†, "On Governing Colonies", of concentrating less on what is ideal from the European point of view and more on what is practical from that of the African, on the preventive rather than the remedial aspect of public health and the essential idea of the Tennessee Valley Authority, in which the association of the ordinary people affected by the scheme is first secured. Similar ideas are stressed by Sir J. Hawthorn Hall, the Governor of Uganda, in some notes on the economic development of Uganda which preface Dr. Worthington's report.

That the regional aspect is present in the mind of the Colonial Secretary is shown by his recent comments on the eighteen months work of the Colonial Economic and Development Council. Nearly all the thirty-five territories concerned have submitted ten-year development plans, although some plans have been referred back with comments or suggestions. But Mr. Creech Jones has stressed the importance of regional planning and development in contiguous Colonial territories such as East, Central and West Africa, and also in the West Indies. In a memorandum accompanying his dispatch of February 14, 1947, on closer association of the British West Indian Colonies, he refers to the manifest need in all the Colonies concerned for improved facilities for research, including surveys and statistical services, in order that plans for economic development and social welfare may be soundly conceived and wisely executed. Except in co-operation, the Colonies will not generally be able to afford or fully to employ the services of the experts required to fulfil those functions. It was announced in this dispatch (Cmd. 7120. H.M. Stationery Office, May 1947. 9*d*. net) that a conference is to be held at Montego Bay, Jamaica, in September, and its outcome will be watched with great interest by all who are aware of the potentialities which have already been revealed in the Caribbean.

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* Uganda Protectorate. A Development for Uganda. By Dr. E. B. Worthington. Pp. xii+112. (Entebbe: Government Press, 1946.) 2*s*. 6*d*.

* Science, Liberty and Peace. By Aldous Huxley. Pp. 64. (London: Chapman and Hall, 1947.) 3*s*. 6*d*. net.

† On Governing Colonies. By W. R. Crocker. Pp. 152. (London: Allen and Unwin, 1947.) 10*s*. 6*d*. net.

There are other aspects of the man-power situation which are of fundamental importance in all these proposals. Inevitably the formation of a Colonial Development Corporation, like the Ground-nut Corporation, with its various subsidiary schemes and ramifications, tends to widen the range of opportunities which the Colonial Service offers and to call for more varied abilities among the members of that service. No thoughtful reader of Col. Crocker's recent comparative study of British, French, Belgian and other Colonial practice and experience can doubt the need for recruits of high quality to the Colonial Service, the great scope for initiative and responsibility which that service offers, or the need for a new outlook in some quarters and for drastic changes in organisation, practice and the transfer and promotion of staff. Ultimately, it is on the quality of the staff by which the Development and Welfare Schemes are administered, their vision and understanding of the needs and minds of the native peoples, their appreciation of the contribution of science, of the problems and opportunities of the private and public corporations seeking to serve the needs of the native peoples and of the world, that success will depend. Nor will the ablest men and women be forthcoming and their zeal and enthusiasm maintained unimpaired unless the conditions of service are such as to call forth their best efforts and to give them the continued stimulus and incentive that will spring from manifest participation in the high task not merely of serving the material and social needs of the Colonial peoples, but even more of training, inspiring and guiding their future leaders in accordance with those new conceptions of imperial responsibility which mark the third Colonial Empire now developing. It should be a first pre-occupation of the Government to see that no timidities or inhibitions of Colonial administration are allowed to hinder the full use of all the expert knowledge of Colonial resources and methods of treatment that have been accumulating in the last four years, or the vigorous prosecution of the fresh researches still required. Above all, nothing must be allowed to frustrate the boldness of imagination with which these new opportunities must be served.

CHEMICAL CRYSTALLOGRAPHY

Chemical Crystallography

An Introduction to Optical and X-ray Methods. By C. W. Bunn. Pp. xii+422+13 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1945.) 25s. net.

PROF. VICTOR GOLDSCHMIDT used to say that, over the door of his laboratory in Heidelberg, he would like to have written "Die Kristallographie ist die Königin des Wissenschaften"; and while he said this chiefly because he personally was fascinated by the external shapes of crystals and their formal geometry, he may perhaps also have thought of crystallography as holding a distinctive place among the sciences, at once isolated and yet pervading. Indeed, crystallography as we know it to-day is in many ways a curious subject. It has come to be principally concerned with the use of X-ray diffraction effects to study, to varying degrees of precision, the arrangement of the atoms in substances, many of which can scarcely be called crystalline at all. The techniques employed belong largely to mathematics and physics, and the information derived is of fundamental importance to subjects so far apart as metallurgy and biology, and particularly to chemistry. There seems, perhaps, something unsatisfactory in the way we cling to so precise a term as 'crystallography' to cover all these developments. Yet, as the combined international body of 'crystallographers' discovered in recent discussions, it is difficult to find any other term to which we can give all the meanings we associate now with the word 'crystallography'.

There is more than one reason for this situation. Without the early classification of the geometrical form of crystals and the mathematical developments of space-group theory, the problem of structure analysis by physical methods is at least much more difficult. Far more of the kind of exact data on which most interest centres—the details of the arrangement of atoms in space and the exact distances between them—can be got once a really crystalline substance is available (some justification for all the hours that have been spent in chemical research in the preparation of 'a crystalline derivative'). But the apparently complex background of knowledge, mathematical, physical and crystallographic, which is required for the proper use of X-ray analysis, makes the subject too often seem too difficult just to those who should find its applications most useful, and particularly to students and research workers in chemistry.

It is the great merit of Mr. Bunn's book that it does very largely attempt to develop a new approach to the study of crystallographic methods based on the use in chemical research of a variety of ways of observing crystals and their structure, both new and old. This new approach is extremely practical. It is designed to meet the needs of those who wish to know, in the first place, what types of chemical information can be gained by using crystallographic methods, and secondly, the essential practical and theoretical details necessary for operating these methods. The relations between these different aspects of the subject are outlined in a very clear general survey of the field which forms the opening section of his "Chemical Crystallography". This survey indicates the limitations as well as the applications of X-ray methods; it also describes the general division of the subject-matter of the book into different, more specialized sections.

The primary purpose in chemical research of getting a 'crystalline derivative' is usually for the identification of different chemical individuals. The assistance which can be given in this direction by crystallographic techniques, particularly crystal morphology and optics and X-ray powder photographs, forms the subject of the first major division of the book. Around this theme is developed the necessary formal information on the types of crystal symmetry possible, on the examination of optic figures and the measurement of refractive indices, and also elementary theory of X-ray diffraction. Here there are important contributions to the presentation of the subject as a whole. For example, the indexing of crystal faces is notoriously difficult for the non-specialist to appreciate. Mr. Bunn begins by showing excellent photographs of crystals growing, and leads by easy stages through the relation of the observed crystal layers to the packing of atoms in space, and so to a derivation of indices for the crystal faces which seems both natural and simple. Further, this derivation presents the indexing process in a way which is very helpful in the later consideration of X-ray analysis.

The second part of the book is devoted to structure determination. It covers both the experimental methods of X-ray photography, the indexing of the more important varieties of photographs, and the actual processes of deduction of the atomic positions from the experimental observations. The methods are illustrated by a section which gives a variety of examples of actual structure determinations carried out both on inorganic and organic substances, and also on certain types of imperfectly crystalline material, for example, long-chain polymers. The use of Fourier series, both in the determination and refinement of structures, is (rather briefly) described. Crystallography is, like all good sciences, also an art, and the methods of practising it differ in the hands of different investigators. One realizes in the course of these chapters not only the variety of the problems of structure analysis, but also something of Mr. Bunn's own position as a successful 'artist' with his own particular approach to these general problems. His own technical contributions in this field are already having considerable effect on the general strategy of X-ray analysis, particularly his practical development of Bragg's optical diffraction method, which is here for the first time fully described. The section concludes on quite different topics, the bearing of crystallographic research on what has been termed the 'texture' of materials, the calculation of particle size from broadening of X-ray lines, and the determination of strain.

I suppose it would be impossible for any book to cover so wide a field as this in a new and individual way without leaving openings for criticism. It seems rather unnatural, for example, to describe powder photography before single-crystal photography. Certain sections seem really too short for maximum usefulness; for example, that on crystal structure and physical properties. There are also a few misprints in the book (for example, the formula on p. 158), and one section at least, that on rhombohedral lattices, p. 135, which is quite misleading. But almost immediately, arguments arise in defence at least of Mr. Bunn's general treatment. There are definite practical advantages in the association of powder photography with other methods of crystal identification; and any great lengthening of an individual section would certainly detract from the usefulness of the book as a readable and coherent survey of the field as a whole. The serious student of the subject has, sooner or later, to turn to original papers, and for this purpose excellent references are supplied.

Taken all together, this book is most welcome. It is very clear and easy to understand, and also beautifully and plentifully illustrated. It has already proved its value in crystallographic teaching and practice, and should play an important part in the development of the subject as one of the established tools of chemical research in the widest sense. But while Bunn's "Chemical Crystallography" is certainly a book that has been badly needed, it may perhaps be fair to add that it is not the only badly needed book on the subject of crystallography to-day. Many of the chapters here could usefully be enlarged into monographs or even text-books. It is to be hoped that some at least of these books are in process of construction.

D. Crowfoot

EXPANSIONS IN EIGENFUNCTIONS

Eigenfunction Expansions associated with Second-Order Differential Equations

By Prof. E. C. Titchmarsh. Pp. vii + 176. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 20*s*. net.

The subject of Prof. Titchmarsh's book is the expansion of an arbitrary function in terms of the eigenfunctions of linear differential equations; to be precise, in terms of functions which satisfy an equation of the form

$$\frac{d^2y}{dx^2} - q(x)y + \lambda y = 0. \qquad (1)$$

Problems of this nature arise in the theory of vibrations of elastic media, where we wish to express an arbitrary vibration in terms of the stationary vibrations: here the corresponding equations are the classical Sturm–Liouville equations. During this century, similar problems have become important in connexion with the Schrödinger equation of quantum mechanics; the physical problem corresponding to the mathematical problem of the expansion of an arbitrary function is the expression of an arbitrary state of a system in terms of the eigenstates of an observable. The corresponding differential equations are of singular type; that is, the interval involved is infinite, or the function $q(x)$ becomes infinite at the ends of the interval.

Prof. Titchmarsh has devoted most of his attention to the singular case for an infinite interval. The ordinary Sturm–Liouville problem is dealt with briefly in one of the early chapters. The rest of the book is devoted mainly to the consideration of the nature of the spectrum, that is, roughly speaking, of the set of values of λ for which the equation (1) has solutions, and to the convergence of the resulting expansions for arbitrary functions. In many cases the spectrum consists of isolated points, and the resulting expansion is a series similar to a Fourier series; in other cases the spectrum consists of all the points of an interval and the expansion is an integral, similar to a Fourier integral; in other cases, of which the Schrödinger equation for a hydrogen atom is a notable example, there is a combination of both types. A very interesting chapter shows how these different cases result from different types of behaviour of $q(x)$ as x tends to infinity.

Another important problem is the distribution of the eigenvalues, or of the size of the n^{th} eigenvalue when the eigenvalues are arranged in order of magnitude. Results are given for this in which the semi-intuitive arguments of physicists are replaced by rigorous analysis.

The greater part of the book is devoted to the convergence or summability of the expansions. These have in the past been treated in the general case almost exclusively from the point of view of convergence in mean square, and results for ordinary convergence or summability at a point have been obtained in the main only for particular cases. Prof. Titchmarsh gives results for the convergence of these expansions when the function $q(x)$ obeys certain sets of conditions which hold in the important particular cases; and he shows that under wider conditions the series expansion is summable to the function represented: this function must obey the same conditions as are necessary for the convergence or summability of a Fourier series.

In the past these problems have been treated either on the basis of the theory of integral equations or the theory of linear operators in Hilbert space. Prof. Titchmarsh has used the theory of functions of a complex variable, and makes no appeal to the methods mentioned. His method is to express the solution of the equation as a contour integral and then to get his results directly by the powerful methods of contour integration. The earlier treatments are perhaps more suitable for a discussion of mean square convergence, or for unifying the theory with that of integral equations and other linear operators, but are certainly more difficult to apply to the study of the problems here treated.

The book has the lucidity and mastery of analytical method which characterize the author's well-known books on the "Theory of Functions" and "Fourier Integrals"; but unlike these it gives not an exposition *ab initio* of the subject as a whole but only of results and methods for the problems mentioned above, which were very largely developed by Prof. Titchmarsh in his recent papers on the subject. It does not attempt an account of the physical background of the subject. All the important special cases are dealt with as examples, but without detailed accounts of the special functions involved which are dealt with in the standard treatises on differential equations. However, a reader with a knowledge of complex variable theory should be able to follow the analysis. As a whole, the book is an important contribution to analysis, and should prove of interest to mathematical physicists as well as to mathematicians.

NAMES INTO CIPHER

A New Notation and Enumeration System for Organic Compounds

By Dr. G. Malcolm Dyson. Pp. iv + 63. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 7*s.* 6*d.* net.

WHAT Dr. Dyson has given us in this volume is less a book on nomenclature than a 'blueprint' or a code manual for the professional indexer. Although the system of notation which he describes demands, and indeed merits, careful scrutiny and examination by organic chemists who are specialists in different fields, it can scarcely be regarded as a contribution to the problem of organic chemical nomenclature properly understood, and the ordinary organic chemist will find what he requires in Dr. Dyson's original lecture last October as since published by the Royal Institute of Chemistry rather than in the present book. The major part of the book is devoted to a careful and detailed exposition of Dr. Dyson's system of ciphering, in which the basic carbon skeleton is first ciphered by a linear series of letters and numerals, with the assistance of commas, stops and semi-colons. All fused-ring systems are enumerated in terms of six conventional ring systems. The functional groups are then similarly ciphered, and the system is logical as well as ingenious and concise. Dr. Dyson claims, moreover, that it has the advantage that there is only one possible cipher for any one chemical compound.

That is an impressive claim, and has to be weighed carefully against any doubts one might entertain as to the unfailing accuracy with which the ordinary organic chemist would apply the rules in practice; and equally, his unerring eye not merely for departures from the logical application of the rules but also for mechanical errors in the transcription of the cipher. An error in nomenclature is usually self-evident to an expert in a particular field, but this is scarcely true to the same extent of a cipher or indeed of a number; and that is probably one reason why the Universal Decimal Classification is unlikely ever to be adopted as a working tool in the indexing of organic chemical compounds.

Dr. Dyson appears, in fact, to have dismissed this question of nomenclature too summarily, and what he has to say under this head is much better put in his original lecture. He does not here show sufficient apprehension of the purposes of nomenclature, or of those relations between its users which are responsible alike for the introduction of trivial names and for departures from systems. Granting that such names as 'coronene', 'phthalazine', or 'rubicene' have been coined because there are no satisfactory systematic alternatives, regarded as symbols, for certain purposes, they may prove as satisfactory as the ciphers suggested by Dr. Dyson. It must be remembered that in particular fields, such as dyestuffs, or synthetic resins or other plastics, the organic chemist will think in the units of which the structure is built up: no dyestuff chemist would attempt to use the systematic name for dianisidine blue, any more than the plastics chemist would trouble with a systematic name for nylon. The trivial or systematic names of the substances brought together in practice in these complex molecules serve the needs of the chemist, even when he is accustomed to use the punched card technique as a regular tool.

The point has been elaborated because the future of the Dyson notation, once its logic and adequacy have been approved in a representative range of special fields, appears to depend on the use to which it is likely to be put. For the reason just given, its adoption by the industrial chemist is unlikely; and when we turn to consider its potentialities in regard to the production of a new lexicon of organic chemistry, a new 'Beilstein', or international indexing and abstracting, it should also be remembered that the present situation is unsatisfactory not only through confusion between different systems of nomenclature and failure to agree, but also for financial reasons. Empirical formulæ, for example, apart from the possible use of the Universal Decimal Classification, already provide a basis for such production if the necessary financial means to the end were willed. That financial aspect needs to be much more carefully examined before any decision is reached, or we may be in danger of finding that Dr. Dyson has prescribed a sledge-hammer to crush a nut.

Despite the ingenuity and logic of Dr. Dyson's notation, in this volume he appears to have missed an opportunity. He should have dealt much more persuasively with established systems of nomenclature, as he did in his original lecture, before proceeding to detail the new notation. A little more trouble in exposition of these systems and of present tendencies would have assisted him considerably to gain acceptance for his idea that a cipher rather than a systematic name is the best means for reference, classification and indexing. Finally, it might be observed that in production the volume compares badly with the lecture issued by the Royal Institute of Chemistry. Neither paper nor print are up to that standard, and to issue unbound at this price a volume which obviously demands close study and constant use is a serious defect.

R. BRIGHTMAN

WATER SUPPLY AND BIOLOGY*

By Prof. W. H. PEARSALL, F.R.S.

University College, London

WATER supply undertakings are primarily concerned with the production of an adequate supply of water of purity suitable for human and industrial consumption. Three features require attention. For human consumption it is of prime importance that the water must be free from deleterious substances and from disease-causing organisms. Secondly, for any purpose, uniformity of quality is a great virtue, and the quality must be such as to include freedom from unpleasant tastes or smells as well as from the more noticeable forms of chemical contamination. (We may leave on one side the question of the suitability of certain types of water for particular industrial uses.) Thirdly, the volume of water required is becoming an increasingly important factor in the problems of supply.

Great Britain has long enjoyed the provision of an admirable water supply. This is now taken for granted, and its advantages are so rarely realized that little credit is given to those responsible. We owe it primarily to the labours of the Rivers Pollution Commission in the 1850's and 60's.

The problem at that time was associated with a series of epidemics of typhoid fever and dysentery. It had been recognized that these were probably water-borne diseases, although due to germs which were excreted in human fæces. All water supplies which could be contaminated by human or animal excretions might thus be suspect, and the Rivers Pollution Commission was called on to investigate the matter and to survey the water resources of the country from this point of view.

They tackled the problem mainly by chemical methods, making use of the fact that animal organic matter is rich in nitrogen, a feature in which it contrasts markedly with plant materials. Thus in the former case the organic C/organic N ratio is low—and this is, in practice, coupled with a high rate of transformation of the material by bacteria to oxidized and inorganic forms of nitrogen-like nitrates. Two chemical features thus make a water suspicious from this point of view—a high nitrogen content and the presence of organic matter with a low C/N ratio.

I mention these activities of the Rivers Pollution Committee because their appreciations and methods were far in advance of their time, and 60–70 years were to elapse before it was generally realized that their technique for describing the origin and breakdown of organic matter was a fundamental one.

The attack on the problem of contamination by fæcal matter led also to the recognition of the fact that almost all surface waters were potentially dangerous. No better illustration of this fact can be given than what happened in Glasgow. There, in 1859, a public water supply from Loch Katrine replaced the numerous shallow wells that had formerly been used. Prior to 1859 a series of three typhoid epidemics had each resulted in the loss of more than two thousand lives. In epidemics, after that date, the number of lives lost fell to about one hundredth of the former number, and in all cases the infection was found to be associated with the continued use of the original supply from shallow wells.

The chemical methods formerly used for determining the character of water supplies have gradually been supplemented and largely replaced by biological methods. These make use of the fact that animal excreta constantly contain certain bacteria which survive for a time in water; but are unable to multiply materially under natural conditions. Particularly useful in this respect are forms like *Bact. coli.* and *B. welchii.* Thus use is now made of the presence or absence of such organisms under prescribed trial conditions to test for the freedom of the water examined from possibly dangerous contamination. To these testing methods have been added the use of bactericidal treatments, which have reduced the dangers from water-borne disease bacteria to vanishing point. Under modern conditions even isolated cases of typhoid fever or of other water-borne diseases are almost unknown, and they cause great consternation when they occur, as in the case of the Croydon epidemic just before the War. The freedom from such epidemics is due to the efficient methods of treatment and bacteriological control now employed.

The most recent developments in water supply problems are also associated with biological matters. Many of the difficulties in the way of efficient water-supply result from the large volumes required. These have risen steadily not only owing to improved methods and standards of sanitation but also to the development of industrial processes with a high water requirement. The aggregation of population in industrial Britain has greatly exaggerated the tendency, and it is becoming increasingly difficult to envisage the continuation of the present conditions without some system of overall planning, for all the larger centres of population must import water from a distance.

It is not, perhaps, generally realized that, in many rural areas also, existing population nearly or quite suffice to use all available supplies. In some areas, Derbyshire for example, no further increase in the rural population is possible. The difficulties in the way of obtaining adequate volumes of water have various effects. In southern England it has long been necessary to use river waters always more or less contaminated by sewage and by manurial treatments on the agricultural country through which they flow. It is only possible to use these waters safely because of the great improvements in bactericidal treatment and control now available.

The maximum amount of water available in any one place is the difference between the amount falling as rain and that evaporated back to the air. It is usually equivalent to about 10–12 inches of rain per annum in southern England. Rainfall is seasonal, so that it must be stored until required in the summer. The storage can be natural, underground stores as in the case of porous rock strata like chalk or limestone. The alternative is to utilize impounding reservoirs, and because these offer a habitat for plants and animals to grow in, many of the biological problems of water supply centre around the control of impounding reservoirs.

The organisms that appear may impart unsuitable quality or unpleasant tastes and smells to the water; but even if they do not, their presence necessitates filtration, and the quantities that at times must be removed add greatly to the difficulties of the water engineer. The algæ are the principal offenders in this respect, particularly diatoms and blue-green algæ. Some indication of the magnitude that the problems of filtration may assume may be gleaned by the following example, illustrative particularly of conditions near London. A reservoir receiving water from the Thames and containing about 7 thousand million gallons might contain at times 110 tons of a single alga, *Fragilaria crotonensis*, measured as dry matter, and roughly a thousand tons as live algæ. From the volume of water normally filtered this involves a daily removal of at least a ton of dry weight, roughly equivalent to at least 10 tons of living alga.

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*From a Chadwick Public Lecture delivered in the Chelsea Physic Garden on June 19.

It will be realized, then, that during periods of abundant algal growth, the algæ alone greatly complicate the problems of a waterworks engineer, for rapid replacement of filters becomes essential. Similar problems are sometimes presented by other aquatic organisms, notably the Cladocera or water fleas. However, the algæ and other aquatic plants have an especially important role because they are the producers of organic matter in fresh water, utilizing light energy and dissolved salts in building up new organic materials. As a general rule the abundance of sub-aqueous life is correlated both with the abundance of algæ and also with the amounts of certain mineral nutrients which are likely to limit their growth. The concentrations of bicarbonates, of nitrates and of phosphates are particularly important in this respect; but in some cases, as in some of the English Lakes, the continued growth of the diatom, *Asterionella*, is apparently limited by depletion of silica, which must exceed a concentration of 0·5 parts per million. There is also some evidence that the presence of high proportions of blue-green algæ in a water can be correlated with an abundance of dissolved organic matter.

Although there are many gaps in our knowledge of the factors which make for algal abundance, it is quite clear that as a general rule certain algal types are indicative of certain water conditions. It is known, for example, that the course of recovery from organic pollution in a stream can be traced by the sequence of algæ found below the pollution source. The influence of the dissolved salts on the algal flora is equally evident in unpolluted waters. In mountain regions, as in some Connemara lakes studied, the different floras characterize the more calcareous waters, and there are distinct elements indicative of peaty waters; while it was long ago noticed by Dr. G. S. West that the faintest traces of pollution by animal fæcal matter results in an abundance of diatoms. In fact, the organic life of a body of water is far more sensitive to traces of pollution than is usually supposed. The biological character of a piece of water depends so much on salts like nitrates and phosphates, the oxidized products of organic matter, that even traces of a completely oxidized sewage effluent usually suffice to change the flora and fauna qualitatively, and they will certainly enrich it quantitatively.

It follows from these facts that the biological analysis of the algal flora is capable of giving information of great value as to the quality of a water supply. At the same time, the recognition of the importance of the reservoir as a biological system would do much to simplify the water engineer's problems, and it may be useful to outline the problem from this point of view. Any deep body of water consists of two depth zones, an illuminated zone producing algæ and organic matter and well aerated as a result of photosynthesis, and a deep zone in which organic matter is broken down and oxygen is consumed. The rate of the latter processes is normally highest at the surface of the bottom mud, and consequently, as the temperature rises, the mud and the water above it may become devoid of oxygen or *anaerobic* whenever there is a large supply of organic matter. Under anaerobic conditions, nutrient salts rapidly diffuse from the mud to the water, ultimately to become available once more for plant growth in the surface layers of the water. If, however, conditions remain such as to maintain a higher oxygen supply at the mud surface, little or no diffusion of nutrient salts to the supernatant water is possible. The development of anaerobic conditions at the mud surface thus greatly increases the rate of circulation of plant nutrients, and especially the size of the vernal algal phase. The matter has a considerable bearing both on reservoir design and filtration difficulties.

It seems clear that the reservoir form ought to be one of low surface volume ratio designed to avoid oxygen deficiency in the lower layers, with an oxygen reserve sufficiently large to give a margin over the summer oxygen consumption, while the small surface should allow comparatively little production in the surface layers. Pertinent data here would presumably be obtained from estimates of the 'biological oxygen demand' and the potential algal or zooplankton production.

The development of oxygen deficiency in the deeper waters of a reservoir has direct effects on the water quality, as well as the indirect ones which result finally in greater algal production. One of these is that ferrous iron compounds appear in solution. These are at some later stage oxidized and redeposited in the ferric state, often in the pipes of the supply system. The processes involved are catalysed by certain iron bacteria, and they not only lead to the blocking of supply pipes but also to the unsightly staining of bathroom furniture.

Equally common under these conditions of oxygen deficiency is the presence of hydrogen sulphides or of other metallic sulphides, with particularly unpleasant smells. These cause great trouble in some calcareous waters containing much organic matter, and they have been a particular source of trouble in the filter beds of tropical and sub-tropical regions.

It is evident, from whatever angle it is approached, an important biological problem in water-works is that of reducing production. In southern and eastern England, where the drainage water is mainly from fertile land, the water works engineer must, if surface water is to be used, resign himself to the need for filtering off large quantities of algal and other organic material. In this case, topography and the need for bacteriological and chemical control of the product usually prevents even an approach to the ideal in reservoir form, while the use of the drainage area for agriculture prevents any attempt to sterilize it or reduce the productivity of the inflowing waters. It can be asked of the freshwater biologist that he forecasts the probable periods of greatest load in the filtering plant, a possibility dependent upon the recognition and maintenance of a seasonal rhythm in algal growth as well as an increased knowledge of the physiology of the organism concerned.

It is, however, also reasonable to inquire whether these steps wholly exhaust the possibilities. A profitable line of inquiry would be to consider whether the intensity of production at peak periods could be reduced and spread out over a longer period or diverted into other channels.

A reduction in algal growths has usually been brought about by the use of algicides, of which copper sulphate is most popular. There is some justification for employing such methods to retard algal growth, but little or none, other than dire necessity, for using them to destroy heavy growths, for the result is almost certainly to result in overtaxing the oxidizing agencies in the reservoir or filtration system, leading to the establishment of anaerobic conditions. In practice, moreover, copper sulphate is known to have other disadvantages; one of them is that more resistant algæ replace the earlier growths, and in some cases these are small enough to pass through filters. A second disadvantage is that there is an increase in the sulphur content of the bottom mud, and when oxygen deficiency develops, the bottom water acquires a high concentration of sulphides. To this agency, also, has been ascribed the later appearance, in some quantity, of sulphur bacteria.

Particularly striking effects are due to these organisms when they are pigmented forms such as *Rhodococcus*, which at times may colour water pink.

From the point of view of water supply, north-western Britain has the great advantage of being an area of high rainfall, of mountain and moorland, and of soils and water of low fertility. The control of reservoirs in such an area presents quite a different series of problems. The first of these is that though the initial fertility of a water is almost always low, yet it is already known that after 30–50 years reservoirs have developed algal production to a high degree. This falls in line with the discovery that certain of the English lakes are accumulating nutrients (nitrogenous materials, for example). In summer more nitrogen enters the lake by the inflows than goes out down the outflow, and it seems that this state of affairs must be not infrequent. Moreover, in winter, the amount of available nitrogen (for example, nitrates) in a natural water is generally at a maximum. If we store this water instead of allowing it to escape to the sea we are, in effect, putting a trap for plant nutrients into the system, so that the annual production is in any case likely to rise.

It seems clear, therefore, that any measure which will tend to reduce fertility in these waters will be valuable. Even if it were only possible to remove a small percentage of the circulating nitrogen and phosphorus, for example, it might suffice to remove the annual accumulations in the lake system.

The question of how to remove part of the annual crops of organic matter becomes a very important one in this particular instance. The obvious way of cropping a reservoir and of obtaining some financial return for the labour involved is to take a crop of fish or of some other cash product from it. The annual crop should equal the annual gains of nitrogen, for example, or else should help dissipate it. From the point of view of the economy of the country as a whole, indeed, the whole of the valuable nitrogenous compounds could profitably be removed from the water. What are the conditions and limitations of this ideal? In effect, the production of organic matter in water passes along a series of food chains—starting generally from algæ, passing by various stages, such as plankton, molluscs and insect larvæ, for example, into fish. Now in each of these steps there is a considerable loss of production. To take a more familiar example, a mature sheep has eaten about ten times its own weight during its growth and development. Thus if this sort of difference is usual, a food chain, containing four steps: *a* (algæ), *b* (insects), *c* (small fish), *d* (larger fish), would give relative productions as percentages of the initial production mechanism of:

(*a*) 100, (*b*) 10, (*c*) 1, and (*d*) 0·1.

(It is, however, perhaps likely that the ratio of weight of food to weight produced is less than that used; about 5 to 1 has been suggested for freshwater creatures.) Generally speaking, water-works practice does not favour fish production in their impounding reservoirs, and to this extent it limits the possible food chains. Clearly, also, the method of operation collects the primary producers (algæ), and so has to deal with the largest weights, though at the same time it probably removes the largest amounts of carbon and nitrogen. However, the algal maxima are short-lived, and it would be advantageous to be able to crop at any time. This means using long-lived creatures for crop-taking.

In contrast, those interested in fish production may obtain higher yields by the shortening of the food chains. It would, for example, greatly increase the yield if, say, the fish (*c*) could be taken rather than another piscivorous fish (*d*); and better still, herbivorous species of fish should give higher production than any carnivorous species.

The piscicultural and the water-works problems are thus both different aspects of one which has equally important bearings on our natural economy to-day—for in these lean times, we are deeply concerned with obtaining the maximum yield from our diminishing acres. It may, therefore, be interesting to collect data comparing the productivity of water and of land in comparable terms.

Yields in lb. per acre

Land: Meat only, 190.
Wheat, 1,800–2,000*.
Beet (as sugar), 3,000*.

* Approximately equivalent to *dry* weight.

Water: Thames water—*c*. 1,400–2,000* maximum algal.
Lake Mendota—Total plankton, *c*. 10,000*.
Algæ in water, say, 6,000*.
Submerged shore-weeds, 1,500–1,800*.

* Dry weight.

Fish: 6– 10, Alpine lakes.
170–180, Illinois river.
180–200, carp ponds (manured).

The estimates for Lake Mendota plankton assume that it is renewed weekly. I think this may be two or three times too often. The data for average dry weight of green plants on the shores of this lake suggest that algal production in the plankton might be 2–3,000 lb. per acre as dry weight, a somewhat similar figure to the estimate for vernal production in Thames water.

It will be seen that the productivity of fertile waters approaches that of the fertile lands from which they drain and the richness of which they contain. From the point of view of conserving natural resources there is much to be said for exploiting the reserves of nitrogen and phosphorus which are otherwise being washed away to the sea. It may be that when we use fertile surface waters for water supply purposes, some system of preliminary crop-taking might be introduced—shallow reservoirs the bottom mud of which could be often removed, or used for a system of water-meadows or for fish-cropping. At any rate, it seems that the desirable biological control of water resources involves consideration of these matters.

TOXIC PROPERTIES OF ω-FLUOROCARBOXYLIC ACIDS AND DERIVATIVES

By Dr. B. C. SAUNDERS
University Chemical Laboratory, Cambridge

We have already reported[1] upon the highly toxic nature of fluoroacetic acid, FCH_2COOH, and its derivatives. The present communication gives an account of further work on the toxicity of allied compounds. The earlier part of the present investigation was carried out under the ægis of the Ministry of Supply during the War, and reports were submitted to that Ministry from time to time and were made available to American workers. The more recent parts of the work have been sponsored by the Imperial Chemical Industries, Ltd. (General Chemicals, Widnes). We are grateful, therefore, to the Chief Scientist, Ministry of Supply, for permission to publish the details of the reports to the Ministry of Supply, and to Imperial Chemical Industries, Ltd., for grants which have enabled us to continue the work.

Methyl fluoroacetate[1,2] was shown to be a convulsant poison and highly toxic by inhalation and by injection; the L.D. 50 for subcutaneous injection into mice being of the order of 7 mgm./kgm., and the figure for intravenous injection into rabbits being 0·25 mgm./kgm. The toxicity figures for fluoroacetic acid were of the same order, and the symptoms produced by the free acid were identical with those produced by the methyl ester.

We then demonstrated that a large variety of derivatives of fluoroacetic acid exhibited the same order of toxicity as that shown by the acid itself. For example, $FCH_2COOC_2H_5$, $FCH_2CONHCH_3$, and $(FCH_2CO)_2O$ were almost equally toxic. Fluoroethyl alcohol, FCH_2CH_2OH, and the aldehyde, FCH_2CHO, were also of the same order of toxicity, whereas fluorochloroethane, FCH_2CH_2Cl, was non-toxic. These results indicated that a compound which could give rise to fluoroacetic acid either by hydrolysis or oxidation was toxic[3]. In other words, the toxic principle appeared to be fluoroacetic acid, or the fluoroacetate ion.

American workers[4] reported that esters of 2-fluoropropionic acid, FCH_2CH_2COOH, were non-toxic, and that esters of 3-fluorobutyric acid were toxic. In June 1944 we announced[5,6] that we had synthesized ethyl 5-fluorohexoate, $F(CH_2)_5COOC_2H_5$, a stable colourless liquid. We found that the toxicity of this compound was very high, and by injection into mice had an L.D. 50 of about 4 mgm./kgm. Ethyl 5-fluorohexoate was therefore about three times as toxic as methyl fluoroacetate (per molecule).

We showed in April 1943 that 2-fluoroethyl fluoroacetate was about twice as toxic as methyl fluoroacetate by inhalation[7]. It seemed likely then that the 2-fluoroethyl ester of 5-fluorohexoic acid might be a compound of outstanding toxicity, and this proved to be the case[6]. This compound was made by the method as outlined below:

$$Br(CH_2)_5COOH \xrightarrow[H_2SO_4]{FCH_2CH_2OH} Br(CH_2)_5COOCH_2CH_2F$$

$$\xrightarrow{AgF} F(CH_2)_5COOCH_2CH_2F.$$

The L.D. 50 of 2-fluoroethyl 5-fluorohexoate, as determined by subcutaneous injection into mice was 2·5 mgm./kgm., that is to say that it is about eight times as toxic as methyl fluoroacetate (per molecule).

For purposes of comparison, the toxicity of methyl fluoroacetate, 2-fluoroethyl fluoroacetate, ethyl 5-fluorohexoate and 2-fluoroethyl 5-fluorohexoate are shown in the accompanying table. The inhalation figures are for 10 minutes exposure. The toxicity of 2-fluoroethyl 5-fluorohexoate, though high by inhalation, was not quite so pronounced as might have been expected; but this is probably accounted for by the fairly low volatility of the compound. For purposes of comparing the toxicities of compounds of low volatility, it is probable that injection experiments are more reliable than inhalation experiments.

Compound	Mice L.D. 50 sub.-cut. inject. (mgm./kgm.)	Mice L.C. 50 Inhal. (mgm./l.)	Rabbits L.D. 50 intra-venous inject. (mgm./kgm.)	Rabbits L.C. 50 inhal. (mgm./l.)	Rats L.D. 50 intra-mus. inject. (mgm./kgm.)	Rats L.C. 50 inhal. (mgm./l.)
Methyl fluoroacetate	7–10	3·2	0·25	0·025–0·05	2·5	0·3
Ethyl 5-fluorohexoate	4	0·2	0·2–0·5		2·3	
2-fluoroethyl fluoroacetate	8·5	0·45		0·05		0·15
2-fluoroethyl 5-fluorohexoate	2·5	0·15	0·1–0·2	0·02–0·05	1·8	0·2

The very high toxicity of 5-fluorohexoic acid and its derivatives is interesting, since by a process of beta-oxidation it could readily give rise to fluoroacetic acid in the body. Similar remarks apply to 3-fluorobutyric acid prepared by American workers. On the other hand, 2-fluoropropionic acid could not, presumably, be oxidized by the beta-oxidation process to fluoroacetic acid.

In order to ascertain more completely whether this striking alternation in toxic properties was fortuitous, we then prepared other ω-fluoro-carboxylic esters, none of which had previously been described[8]. Ethyl-4-fluorovalerate, $F(CH_2)_4COOC_2H_5$, was shown to be non-toxic. On the other hand, we showed that ethyl 9-fluorodecoate, $F(CH_2)_9COOC_2H_5$, was extremely toxic in accordance with expectation, but the toxicity figures were considerably greater than would have been anticipated on the β-oxidation theory. In fact, molecule for molecule, it was much more toxic than methyl fluoroacetate. It may be argued that because of its longer chain, the fluorodecoate would have a higher 'fat : water' distribution, and would therefore pass more rapidly than methyl fluoroacetate through the cell membrane, and there break down giving a higher intracellular

Compound	LD. 50 for injection into rabbits
FCH_2COOCH_3	0·25 mgm./kgm. (in saline)
$F(CH_2)_9COOC_2H_5$	0·2 mgm./kgm. (in propylene glycol*)

* The fluorodecoate would probably be even more toxic in saline, as methyl fluoroacetate appears to be rather more toxic in saline than in propylene glycol.

concentration. It cannot, therefore, be stated with certainty that β-oxidation is the only factor or even the major factor concerned with the alternation of toxic properties.

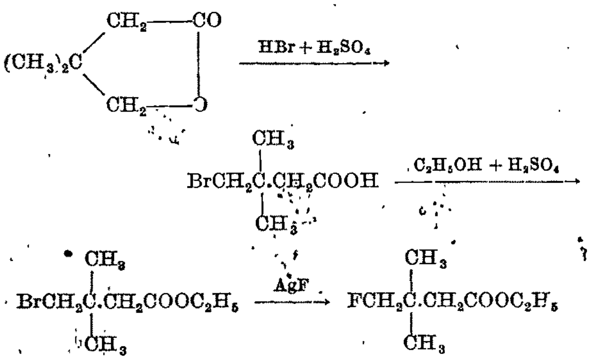
It is also important to keep in mind the fact that 2-fluoroethyl fluoroacetate, $FCH_2COOCH_2CH_2F$, was found to be twice as toxic (by inhalation) as methyl fluoroacetate weight for weight[7]. The rate of hydrolysis of the two substances was found to be similar. One mol. of the former gives rise to one mol. of fluoroacetic acid and one mol. of fluoroethyl alcohol (oxidizable to fluoroacetic acid). Therefore if hydrolysis and oxidation were the major factors concerned, then 2-fluoroethyl fluoroacetate should possess approximately the same toxicity as methyl fluoroacetate (weight for weight). This may indicate that the 2-fluoroethyl fluoroacetate molecule can exert a toxic action *per se*, independent of any subsequent degradation.

In line with this observation, we found that 2-fluoroethyl 5-fluorohexoate was more toxic than the corresponding ethyl ester (by injection). On the other hand, 2-fluoroethyl 9-fluorodecoate does not appear to be more toxic than the corresponding ethyl ester. This result requires further investigation.

We have recently added to the series by the synthesis of ethyl 10-fluoroundecoate, $F(CH_2)_{10}COOC_2H_5$, which was found to be non-toxic, and of ethyl 7-fluorooctoate and 11-fluoroduodecoate, both of which proved to be highly toxic.

Acids Substituted in the β, and in the α and β, Positions

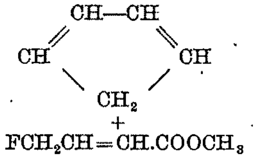
The problem was then approached at a different angle. As already stated, 3-fluorobutyric acid is known to be highly toxic, a fact which could be accounted for on the β-oxidation theory. The process of β-oxidation could presumably be stopped by effectively 'blocking' the β-position in the chain. We therefore synthesized ethyl 2 : 2-dimethyl 3-fluorobutyrate (I) according to the following scheme :



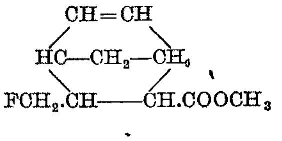
(I)

The compound (I) was found to be non-toxic as expected.

An independent method of approach consisted in 'fixing' carbon atoms 2 and 3 in the highly toxic 3-fluorobutyrate by making them form part of a ring system. Presumably the process of β-oxidation would be inhibited in the new compounds, which should therefore be non-toxic. For this purpose we carried out a Diels–Alder condensation of cyclopentadiene and methyl 3-fluorocrotonate (II), and obtained the compound (III), which was, in accordance with expectation, non-toxic.



(II)



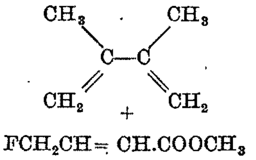
(III)

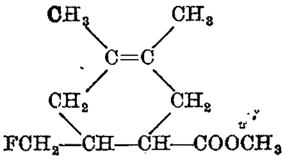
It should be mentioned here that the crotonate (II) had been shown by American workers to be highly toxic. For the present investigation we prepared the compound as follows :

$$\mathrm{CH_2{=}CH.CH_2OH \xrightarrow{Cu_2(CN)_2+HCl} CH_2{=}CH.CH_2CN \xrightarrow{Aq.HCl} CH_2{=}CH\,CH_2COOH \xrightarrow{HCl,\,CH_3OH} CH_2{=}CH.CH_2COOCH_3 \xrightarrow{Br_2} BrCH_2CHBr.CH_2COOCH_3 \xrightarrow{NaOEt} BrCH_2CH{=}CH.COOCH_3 \xrightarrow{AgF} FCH_2CH{=}CH.COOCH_3.}$$

The methyl bromocrotonate was also prepared by the action of N-bromosuccinimide on methyl crotonate.

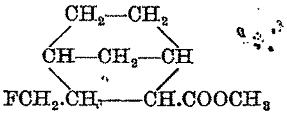
We also effected the condensation between 2 : 3-dimethylbutadiene and methyl 3-fluorocrotonate and obtained the hitherto undescribed compound (IV), which was devoid of toxic properties.



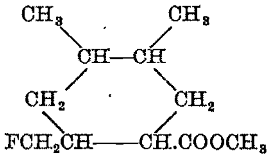


(IV)

It was found that compounds (III) and (IV) could be hydrogenated under conditions which did not remove the fluorine atoms, and the fully saturated compounds (V) and (VI) were also found to be non-toxic.



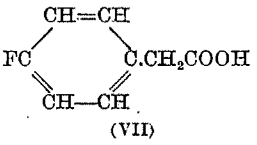
(V)



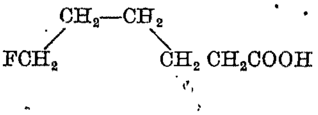
(VI)

Thus five compounds in all were synthesized, containing the skeleton of the toxic 3-fluorobutyric ester. They possessed structures of such a kind that β-oxidation would be unlikely in the animal body. The fact that these new compounds were non-toxic is some evidence in support of the β-oxidation theory. On the other hand, if their toxic properties had been comparable with that of the parent acid, it would have been necessary to have abandoned the β-oxidation theory.

One further compound may be mentioned in this connexion, namely, *p*-fluorophenylacetic acid (VII), which has the carbon skeleton of the highly toxic 5-fluorohexoate (VIII) :

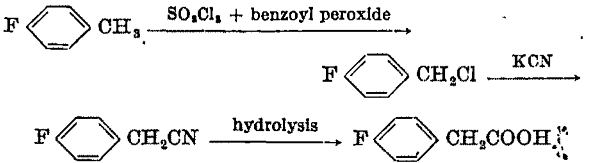


(VII)



(VIII)

The compound (VII) was found to be non-toxic, and cannot, of course, be oxidized to fluoroacetic acid. *p*-Fluorophenylacetic acid had previously been prepared in small quantity by Dippy and Williams[9] by a rather laborious process. We developed a new synthesis of the compound (VII) in good yield as follows :



(VII)

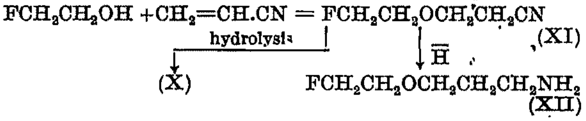
ω-Fluorocarboxylic Acids Containing a Hetero-Oxygen Atom.

We have also devised another method[8] which may throw light on the phenomenon of alternating toxicities and the possible connexion with the β-oxidation process. Here the principle was to replace a CH_2-group at some appropriate point in the chain by an oxygen atom, and then to compare the toxic action of the new compound with that of the parent ω-fluorocarboxylic acid. Thus whereas 5-fluorohexoic acid (IX) and its derivatives are extremely toxic, the corresponding oxygen compound (X) had an L.D. 50 for injection into mice of only 70 mgm./kgm.

$FCH_2CH_2CH_2CH_2CH_2COOH$ (IX) L.D. 50 : 4 mgm./kgm. for ethyl ester.

$FCH_2CH_2OCH_2CH_2COOH$ (X) L.D. 50 : approx. 70 mgm./kgm.

Several compounds of this type have been prepared by a novel synthesis depending upon the cyano-ethylation of the appropriate fluoro-alcohol. Thus the cyano-ethylation of fluoroethyl alcohol (prepared according to the method of McCombie and Saunders[10]) gave 2-fluoro-2′-cyanodiethyl ether (XI) in good yield.



$$FCH_2CH_2OH + CH_2{=}CH.CN = FCH_2CH_2OCH_2CH_2CN \quad (XI)$$

$$\xrightarrow{\text{hydrolysis}} (X) \qquad \xrightarrow{\bar{H}} FCH_2CH_2OCH_2CH_2CH_2NH_2 \quad (XII)$$

It was found possible to reduce the ether (XI) to the corresponding primary amine (XII) by means of Raney nickel and hydrogen, without removing the fluorine atom. The conditions for the reduction were critical and were arrived at only after several failures. This then allowed of the possibility of lengthening the chain at one end of the molecule. Increase in length at the other end of the molecule was achieved by the cyano-ethylation of 3-fluoropropanol.

Utilizing the cyano-ethylation method, the following compounds, all of which are new, have been prepared :

$FCH_2CH_2CH_2OCH_2CH_2CN$
$FCH_2CH_2CH_2OCH_2CH_2COOH$
$FCH_2CH_2CH_2OCH_2CH_2COCl$
$FCH_2CH_2CH_2OCH_2CH_2CH_2COOC_2H_5$
$FCH_2CH_2OCH_2CH_2COCl$
$FCH_2CH_2OCH_2CH_2CH_2COOC_2H_5$

The acid chlorides were converted into the esters of the higher acids by the Arndt–Eistert reaction :

$$F(CH_2)_3OCH_2CH_2COCl \xrightarrow{CH_2N_2} F(CH_2)_3OCH_2CH_2COCHN_2 \xrightarrow{Ag_2O + C_2H_5OH} F(CH_2)_3O(CH_2)_3COOC_2H_5 + N_2.$$

The physiological examination of these ethers is being undertaken at present.

Summary

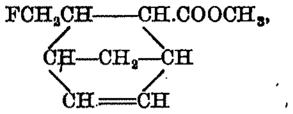
(1) A striking alternation in the toxic properties of ω-fluorocarboxylic esters has been demonstrated as follows :

FCH_2COOR	toxic
FCH_2CH_2COOR	non-toxic (American workers)
$F(CH_2)_3COOR$	toxic (American workers)
$F(CH_2)_4COOR$	non-toxic
$F(CH_2)_5COOR$	toxic
$F(CH_2)_7COOR$	toxic
$F(CH_2)_9COOR$	toxic
$F(CH_2)_{10}COOR$	non-toxic.
$F(CH_2)_{11}COOR$	toxic

These results are discussed from the point of view of β-oxidation in the animal body. The conclusion is that while β-oxidation may be a factor in accounting for this alternation of properties, other important factors are also involved.

(2) Ethyl 2 : 2-dimethyl 3-fluorobutyrate, $FCH_2C(CH_3)_2CH_2COOC_2H_5$, in which the β-position is 'blocked', is found to be non-toxic.

(3) Methyl 2-fluoromethyl-3 : 6-endomethylene-Δ^4-tetrahydrobenzoate,



and three other related compounds in which the α and β positions are 'fixed', are non-toxic.

(4) We have been able to introduce a hetero-oxygen atom at appropriate points in the chain of ω-fluorocarboxylic acids by methods depending ultimately upon the cyano-ethylation of the appropriate fluoro-alcohol. Thus compounds of the general type $F(CH_2)_mO(CH_2)_nCOOH$ have been obtained. The toxic properties of these compounds are at present being examined.

These investigations were carried out by F. J. Buckle, F. L. M. Pattison and B. C. Saunders. We express our thanks to Imperial Chemical Industries, Ltd., for research studentships to two of us (F. J. B. and F. L. M. P.). We are indebted to Mr. K. J. Carpenter and to Dr. W. J. O'Connor, who have performed the animal experiments.

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[1] McCombie, H., and Saunders, B. C., *Nature*, 158, 382 (1946).

[2] McCombie, H., and Saunders, B. C., Reports on Fluoroacetates to Ministry of Supply, Dec. 11, 1942, onwards.

[3] McCombie, H., and Saunders, B. C., Report No. 5 on Fluoroacetates to Ministry of Supply (May 30, 1943).

[4] American workers, by communication.

[5] Saunders, B. C., Ministry of Supply meeting (London, June 1, 1944).

[6] McCombie, H., and Saunders, B. C., Report No. 11 on Fluoroacetates and Allied Compounds to Ministry of Supply (August 8, 1944).

[7] McCombie, H., and Saunders, B. C., Report No. 4 on Fluoroacetates to Ministry of Supply (April 15, 1943).

[8] Saunders, B. C., Report to I.C.I. (Widnes, Dec. 8, 1945).

[9] Dippy and Williams, *J. Chem. Soc.*, 1466 (1934).

[10] McCombie, H., and Saunders, B. C., Report No. 3 on Fluoroacetates to Ministry of Supply (March 31, 1943).

DUNDEE MEETING OF THE BRITISH ASSOCIATION, AUGUST 27–SEPTEMBER 3

AS has already been announced, the British Association will meet at Dundee during August 27–September 3, and a preliminary programme referring to general features of the meeting has been issued. The following notes, from the recorders of the various sections, amplify the information given there.

Section A (*Mathematics and Physics*). In his presidential address, Sir Edward Appleton will deal with the way in which radio has been used in communication and also as a method for investigating natural phenomena, by study of the reflexions from meteors and the reception of radio 'noise' from the sun and Milky Way. The session on September 2, devoted to "Coal as a Source of Heat and Power", will hear Sir Charles Ellis, who will be followed by contributors from the Fuel and the Building Research Stations on the efficient use of fuel and domestic heating systems. Prof. J. D. Bernal will review the question of coal economy, and Prof. D. M. Newitt will speak about the use of oxygen in carbonization processes and the storage of gases in liquid form. The British Coal Utilisation Research Association will deal with the combustion of coal in fuel beds. The discussion of modern methods of computation will include a general survey and a description of some large American machines.

Section E (*Geography*) will devote a whole day to a discussion of Scottish problems from the geographer's point of view. The National Atlas and urban geography will each have a morning. There will be an exhibition of maps produced by the Scottish Department of Health and the Ministry of Town and Country Planning.

Section F (*Economics*). Current economic difficulties will receive particular attention. The presidential address is to be on the "Conditions of the Economic Outlook", and there will be papers on "The Significance of the New Issue Market for the Finance of Industry", "Land Compensation", "Social Accounting", "Profit and Enterprise", "Proposed Code of Industrial Management". A joint meeting with Section J (Psychology) will consider "Incentives in Industry".

Section G (*Engineering*). An outstanding feature will be a series of short papers by junior engineers; thirty minutes is allotted to each speaker for his paper and the ensuing discussion. In preparation for the afternoon visits, the last item of the morning programme will be a summary of what is to be seen.

Section H (*Anthropology*) will hold a symposium on problems of "Culture Change", to which members of the staff of the London School of Economics will contribute. The archæological side will discuss Pleistocene chronology under the title "Dating the Past". Papers are to be presented on a variety of subjects, including the technique of excavation, the education of the totally deaf child, the organisation of folk-life studies, reconstruction in the Naga Hills, and recent discoveries of fossil Hominoidea in South Africa.

Section I (*Physiology*) will hold a joint meeting with Sections H and J to discuss "Man and the Machine", with the object of showing how the physiology, anatomy and psychology of the man should be considered in the design of the machine he is to use. Two other meetings include Section J, when "Aviation Physiology" and "Climate and Health" will be discussed. On August 29 Sir Alexander Fleming will open a symposium with Sections B and K on "Penicillin and other Antibiotics". The use of tracer elements will be the subject of a meeting with Section B on the morning of September 2. During the meeting a Children's Lecture on "Colour" will be given by Prof. H. H. Hartridge.

Section J (*Psychology*). The contributions are mainly of practical interest, industrial and educational applications being especially prominent. The Section joins with others in discussing "Man and the Machine", "Allocation to Secondary Education" and "Incentives in Industry". The sectional meetings include symposia on "Selection for Management", "Public Opinion Surveys", "Rehabilitation of an Industrially Depressed Area", "Changes in Abilities with Age" and "The Scientific Study of National Character". Dr. S. J. F. Philpott's presidential address is "Man's Adaptability".

Section L (*Education*). Miss Grier's presidential address will be on the evolution of secondary education. Miss Lambert will present a paper on the "Problems of Selection Technique at the age of Transfer to Secondary Schools". There will be a discussion on adult education in the Services.

Section M (*Agriculture*). The first session will be a joint one with Sections B and D to discuss insecticides. Papers will be presented (by Drs. H. G. Thornton, M. C. Rayner and A. P. Evans) on three aspects of soil biology—the roles of bacteria, mycorrhizas and earthworms in the economy of the soils and the maintenance of fertility. A session is devoted to recent advances in the control of animal diseases, and at the final session the Right Hon. Walter Elliott, M.P., Sir Jack Drummond and Mr. H. D. Walston will discuss, from the points of view of the agriculturist, nutritionist and economist, respectively, the vitally topical problem: How far could and should Britain feed herself? In his presidential address, Dr. W. G. Ogg will speak on "Soil and Health", and will describe recent studies on the effect of soil conditions on the health of plants and animals.

METALLURGICAL PROBLEMS INVOLVED IN THE GENERATION OF USEFUL POWER FROM ATOMIC ENERGY*

THE design of even the simplest atomic energy reactor, the water-cooled carbon pile using natural uranium, presents many awkward technical problems. Metallic uranium has properties which make it a difficult material to work with. It melts at about 1,150° C.; but below this temperature it undergoes two transitions, with unusually large volume changes. It is very reactive chemically, and readily attacked by water. For these reasons, and to retain the radioactive fission products, the uranium rods in a pile have to be enclosed in gas-tight sheaths, of materials which are good heat conductors, non-corrosive and do not absorb neutrons appreciably.

* Substance of the May Lecture before the Institute of Metals delivered by Sir Wallace Akers, C.B.E., on May 21.

These conditions limit the choice to beryllium and aluminium. Beryllium would be excellent, but so far nobody has succeeded in making tubes from it. Aluminium has therefore to be used, although it is not ideal, as water tends to form surface films, which interfere with the heat transfer. The uranium and graphite have to be purified to a degree hitherto unknown on such a scale; the most important impurity is boron, which seems to be present in very small quantities in almost all reagents. The preparation of aluminium-sheathed rods of uranium of the required purity represents a metallurgical achievement of a very high order.

But even when these difficulties have been overcome, it is unlikely that water-cooled plants will produce useful power. In order to achieve a reasonable thermal efficiency, the water would have to be worked at a considerable pressure; the aluminium tubes would therefore have to be much thicker and would consequently capture too many neutrons. More promising is the use of liquid bismuth, or helium, both of which have very low neutron-capture cross-sections. Even then the pile would have to be very large and its design extremely critical; because the very narrow balance between the number of neutrons produced at fission and those left after capture by U238 and the various materials entering into the construction of the pile necessitates the cutting down of the escape of neutrons and their loss in impurities to a minimum.

Much smaller reactors and greater latitude in design become possible, if, instead of ordinary uranium, material enriched in fissile content is employed. The use of uranium enriched in U235 is not economical because of the high cost of separation; but it is feasible to utilize the production of plutonium by capture of neutrons in U238. This may be of vital importance for the supply of fissile fuel, because if it could be arranged that, for every nucleus of U235 burnt up, one plutonium nucleus were produced, the total number of fissile nuclei would remain constant; in fact, their proportion would increase steadily as U238 is being used up. One cannot say at present whether it would be possible to go further than this and produce more plutonium nuclei than of U235 burnt up. If such 'breeding' of plutonium could be achieved, the problem of availability of supplies of fissile fuel would be solved immediately.

In this respect the production of U233 from thorium is more promising. This is done by placing thorium in the outer layers of a graphite-uranium pile so that it is exposed to neutrons which would otherwise escape. The possibility of 'breeding' is in this case more pronounced, since the number of neutrons ejected at fission of U233 may be sufficiently high to make it possible to build a reactor in which more nuclei of U233 are formed than are burnt up. If this turns out to be practicable, then, having once made some U233 from thorium placed in a uranium pile, we could dispense with natural uranium altogether and continue to produce U233, and generate power, using only thorium as a raw material. Furthermore, this would enable us to utilize, by conversion to plutonium, any U238, from graphite-uranium piles, which became useless owing to the impoverishment in U235.

When will atomic energy be available? As a pure guess it would seem that an experimental plant will be running in the United States by 1949, and that in five to ten years there will be some fairly large power stations generating electricity in various parts of the world. It is impossible to say anything definite about the economics of these plants. The figures quoted recently in the United States depend on several assumptions and data not available in Britain; but for more remote places, without fuel resources, atomic power may well be economical even now. For example, an atomic energy power station might be built to provide power and heat for a large airport near the North Pole, to shorten many important air routes.

The consumption of nuclear fuel is extremely low; one kilogram of fissile material liberates as much heat as the burning of 2½ million kilograms of high-grade bituminous coal. The amount of electrical energy generated in Great Britain is about 50,000 million kWh. per annum. If the heat generated in fission could be utilized with a thermal efficiency of 27 per cent, the consumption of fissile material needed to produce this amount of electrical energy would be about 7½ tons per annum. If only U235 were burnt, the quantity of ordinary uranium required would be about 1,000 tons per annum, which is just what the total world output of uranium was in 1939. Although the production has since then certainly increased, it is clear that uranium has no future for power production if only U235 could be utilized. But if a substantial part of U238 or, still better, if thorium could also be used, then the figures become reasonable.

Contrary to common belief, uranium and thorium are far from being among the rarest elements. In the rocks composing the globe there are on the average about 4 parts per million of uranium and 11½ of thorium, as compared with 0·5 of mercury and only 0·005 of gold. But unfortunately uranium does not occur frequently in large enough concentrations; thorium is rather better in this respect. Granites and rhyolites contain 10 to 20 grams of uranium plus thorium per ton; their 'calorific' equivalent is thus 25 tons of coal per ton of rock; but the very complex nature of the compounds in which uranium and thorium exist in them makes it impracticable to mine and extract the fuel from rocks.

AN INTERNATIONAL UNION OF FAMILY ORGANISATIONS

A MARKED tendency in educational and social thought of recent years, and a tendency accentuated by the strains to which society has been subjected by the War and the ensuing peace, has been the renewed emphasis placed on the family as the basic social unit and as the most powerful educational influence acting upon the individual. It is therefore not surprising that in various countries efforts have been made to set up organisations to co-ordinate activities relating to family life; organisations such as the National Council on Family Relations in the United States, the Family Relations Group in Great Britain, and the Union Nationale des Associations Familiales in France. The next needed step was clearly the formation of some machinery for international information and documentation, and the building of this machinery has now been started.

In Paris, during June 22–29, there was held an International Congress on the Family and on Population. It was attended by some two hundred delegates from twenty-four countries and, although few of the delegates attended with the official support of their

Governments, there seems little doubt that the Congress was fairly representative of the main streams of thought in most of the important countries of the world.

This very fact, indeed, was responsible for what at first appeared to the writer to be a weakness in the Congress. When some delegates were enthusiastic about large families and others little concerned with mere family size, when some were interested in the problems and techniques of family planning and others condemned it as immoral, when some represented still quite patriarchal countries and others countries in which women were fully recognized as the equals of men, it was difficult to get down to any detailed discussion or expert examination. In truth, it could not be claimed that this Congress achieved anything very important in the way of settling the problems of family life. It did, however, provide an opportunity for the exchange of information and widely differing views on housing and home-making; sex education, marriage guidance; and general education for family life; the role of women in general (and mothers in particular) in society; family allowances and other social measures for the strengthening of family life; the role of family organisations in national life, and so on.

Out of this exchange there emerged, despite all differences of opinion, a widespread and deep desire for international co-operation. Most delegates felt that they could learn much, and perhaps most of all from those from whom they differed most widely. Towards the end of the Congress, this diffuse desire for international co-operation gradually crystallized into a determination to set up an international organisation and, at the final session, a resolution to this effect was passed unanimously.

The new organisation is to be called the International Union of Family Organisations; but it was clearly recognized that all decisions as to structure and programme could at present be purely provisional. The British delegates, in common with those from most other countries, felt that they had no mandate whatsoever to commit their countries or even the organisations they represented to anything very concrete. Equally, however, they felt that it would be a great pity to allow this very representative gathering to disperse without forming at least an embryonic organisation. A provisional international committee was therefore set up, a Swiss delegate was appointed as provisional president, and a French delegate as provisional secretary. It was agreed that vice-presidents should, if possible, eventually be appointed from the United States, Great Britain, France, 'Eastern Europe' (by which the U.S.S.R. was generally understood to be meant), Scandinavia, South America, the Near East and the Far East; and, no doubt, it was by an oversight (for these provisional arrangements were necessarily made hurriedly) that Africa and Australasia were not included in this list. Finally, it was agreed that the International Union should be open to all countries, including those not represented at the Congress, and that every effort should be made to work closely with U.N.O. and U.N.E.S.C.O. It is encouraging to be able to report that an observer from U.N.O. welcomed the establishment of the International Union.

Whether the future will see a great strengthening of the new International Union of Family Organisations, or whether it will see its gradual withering, it is as yet impossible to say. Everything depends upon whether the action of the delegates is ratified when they report back to their respective national organisations. One most encouraging fact, however, is that throughout the world to-day there is great interest in the problems of family life. Catholics and Protestants, Capitalists and Communists, all, in their different ways, recognize the importance of the family, and in this lies great hope.

CYRIL BIBBY

NEWS and VIEWS

East African Agricultural and Forestry Research: Dr. B. A. Keen, F.R.S.

DR. B. A. KEEN has been appointed director of the new East African Agricultural and Forestry Research Organisation. The Organisation will work in close association with the corresponding Veterinary Organisation and the Agricultural Departments of Kenya, Uganda, Tanganyika and Zanzibar. For many years Dr. Keen was assistant director and head of the Physics Department at Rothamsted Experimental Station. During 1929–31, at the request of the Government of India, he was seconded as director of the Imperial Agricultural Research Institute to reorganise it. During 1943–45, he was scientific adviser to the Middle East Supply Centre. In 1946 he revisited Palestine to advise on the organisation needed for rural development and also went to West Africa as chairman of the United Kingdom Government Mission to inquire into the production of vegetable oils and oil seeds. Since February 1947 he has been touring East Africa at the invitation of the Governors' Conference to examine agricultural problems and research needs.

Recordings at Kew of the Brest Explosion

MR. J. M. STAGG, of the Kew Observatory, Richmond, Surrey, writes that the effects of the explosion of a cargo of nitrate in Brest harbour on the evening of July 28 were clearly recorded on one of the seismographs and on four barographs at the Observatory, which is 480 km. from Brest. The seismograph, a short-period, vertical component instrument, recorded the first effect at 16h. 48m. 52s. G.M.T. with a second pulse nine seconds later. The biggest amplitude occurred at 16h. 49m. 05s. and the whole disturbance lasted about one minute. The character of the effect on the seismograph closely resembled the effects produced by bomb explosions, flying bombs, etc., in the neighbourhood of the Observatory during the War, when, for the most part, the disturbances were due to airborne sound waves. That the seismograph disturbance was due to the explosion air wave and not to true earth movements is supported by the times of the disturbance recorded by the Kew barographs, including a very sensitive microbarograph. All four instruments showed a sudden pulse (about one millibar) of very short duration in both directions, the mean of the times being 16h. 49m. 0s. ± 15s. The Kew records taken together put the time of the Brest explosion at about 16h. 25m. G.M.T.: there was no indication of an earth movement or an upper air sound wave.

Audibility of Members of Parliament

EXPERIMENTS are being conducted in the House of Lords, in which the House of Commons sits while the Lower Chamber is being rebuilt after destruction during the War, to improve the audibility of members. Comprehension of a speaker's words is low because the first major reflextion, on which reliance is placed by auditors, especially in the rear of a speaker, is scattered by the extensive wooden carving; moreover, the roof is too high to afford any useful reflexions. The acoustic problem is complicated by the premise that any speaker may jump up and address remarks, theoretically to the chair, but often elsewhere. Permission from the authorities has been obtained to install, as an experiment, three hollow tubes acting as hand-rails, one on each side of the House behind the Treasury and Opposition benches, the third in front of the Hansard and some Press reporters just over the Speaker's chair. Each tube is driven by a horn loudspeaker electro-dynamic driving-unit at one end, the other end having an acoustic termination to obviate reflexions. Along the pipe are small holes, so that reproduced sound from the existing system of microphones is emitted just below a member's ear, or in front of a reporter. It is unlikely that a considerable increase in general audibility can be obtained by any means; but the pipe scheme for low-level individual sound augmentation certainly helps the audition of poor speakers, and is of considerable help when the noise-level increases. In particular, the Press are much more certain of getting the remarks of the Speaker. Present trials will indicate whether the pipe system can be extended with advantage, and possibly incorporated in the new Lower Chamber.

Advisers to the Minister of Civil Aviation

LORD NATHAN, the Minister of Civil Aviation, has appointed the following to be his advisers in science, business and industrial relations: chief scientific adviser, Prof. George Temple; chief business adviser, Mr. Leslie Gamage; chief adviser on industrial relations, Lord Dukeston. Prof. Temple is professor of mathematics in King's College, London. He is also a member of the Aeronautical Research Council. He was seconded for specialist duties to the Royal Aircraft Establishment, Farnborough, during the Second World War. Mr. Leslie Gamage is vice-chairman and joint managing director of the General Electric Co., Ltd. For the past four years he has been president of the Institute of Export. He is a member of the National Civil Aviation Consultative Council, representing the Joint Air Transport Committee of the Association of British Chambers of Commerce, the Federation of British Industries and the London Chamber of Commerce. Lord Dukeston was the general secretary of the National Union of General and Municipal Workers. He represents the Trade Union Congress on the National Civil Aviation Consultative Council. He was president of this year's Trade Union Congress, and is the British Government member on the United Nations Organisation Commission to set up a Bill of Human Rights.

Royal Society Empire Scientific Conference

THE preliminary report of the Royal Society Empire Scientific Conference, June–July 1946, which has now been published by the Royal Society, includes the speeches at the opening ceremony with lists of the morning discussions, of the papers prepared for the Conference, of the delegates, etc. The summaries of the discussions given in this report detail the recommendations (see *Nature*, July 27, 1946, p. 136), many of which were afterwards endorsed by the Official Conference. The morning discussions surveyed first some outstanding problems in agricultural science in the Empire, including scientific needs concerned with the soil, the plant and the farm animal. Next some outstanding problems in medical science were discussed, including the physiological and psychological factors affecting human life under tropical conditions and in industry, and the etiology and control of infectious and transmissible diseases, particularly those which are insect-borne. The present state of the science of nutrition was discussed with particular reference to the special problems of the Empire, including the nutritional status of the indigenous peoples of the Colonies. Improvement of that status was recognized by the Conference as a part of general social and economic policy in the territories concerned, and the Conference strongly urged the need for integrating the efforts of producer, consumer, technical and administrative personnel in effecting improvements in nutrition.

Other discussions covered a variety of topics: modern methods of mapping and exploration by air, including the use of radio technique in ordnance survey with special reference to particular parts of the Empire; scientific information services and methods of improving the interchange of scientific workers throughout the Empire, including the future of the scientific liaison offices that were established during the War; Empire co-operation in the scientific field with existing and projected international organisations; physical standards of measurement, the collection of scientific records and material and risks involved in the distribution of plants, seeds and animals, and so on. A general statement on land utilization and soil conservation emphasizes the importance of erosion surveys, soil surveys, and investigations relating to the maintenance and improvement of soil fertility, and urges the importance of surveys to determine the present pattern of and trends in land use, as a basis for the maintenance of soil fertility, bearing in mind the conflict between agricultural and other interests. A discussion on the need for a co-ordinated survey of the mineral resources of the Empire led to a general statement urging the compilation of reliable data on mineral resources. Discussions on the natural products of the Empire and the chemical industries that are, or might be, based on them and on the post-war needs of fundamental research, the latter of which revealed a particular shortage in the Commonwealth of scientific workers in such fields as taxonomy, genetics and microbiology, completed the proceedings.

Textile Industry and the University of Leeds

THE report to the Clothworkers' Company of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, University of Leeds, 1945–46, pays a high tribute to the work of the late Prof. F. M. Rowe. No appointment has yet been made to the research fellowships in dyeing or in physical chemistry; but research workers of the Sisal Growers' Association have continued to be accommodated in the Dyeing Department. Dr. E. Race, in collaboration with Prof. Rowe and Prof. J. B. Speakman, established a new technique for examining the constitution of the dye-chromium complexes obtained when wool is dyed with chrome mordant dyes, and with Dr. C. B. Stevens commenced work on the kinetics of chromium dye complex formation, including a study of the rates of formation and heats of combustion of chromium complexes of a series of dyes. Dr. E. M. Hunt and Prof. F. M. Rowe completed an investigation to establish degradation processes for determining the constitution of indigoid, thioindigoid and related types of vat dyes in substance, and Mr. F. M. Smith commenced a similar investigation of triphenylmethane dyes. Derivatives of catechol have been prepared for examination as intermediates for dyes, and Dr. A. T. Peters has completed an investigation of derivatives of 3 : 4-di-*tert.*-butylacenaphthene and derived indigoid dyes, and with Dr. R. J. Moualim commenced the preparation and orientation of a series of derivatives of 2-*tert.*-butylnaphthalene. Although the entry of British students was seriously affected by the demands of national service, the total number was fully maintained by ex-Service students and students from abroad, and the number of students in the Department of Textile Industries caused serious overcrowding.

The report of the latter Department refers to Prof. W. T. Astbury's election to the newly instituted chair of biomolecular structure, and when his work is transferred to new quarters, the Textile Physics Laboratories will be supervised by Mr. H. J. Woods, who has now been appointed lecturer in textile physics. A new scheme of work on textile finishing has been undertaken by Dr. C. S. Whewell in conjunction with Mr. C. R. Ricketts, and work on wool, rayon, jute and sisal has continued. Messrs. Courtaulds, Ltd., have now made a grant of £60,000 for building and equipping a Division of Rayon Technology within the Department. Lists of publications are included in the report.

Mosquitoes and Yellow Fever in the Sudan

Dr. J. Lewis, of the Stack Medical Research Laboratories, has discussed the relationship of mosquitoes and yellow fever in the Sudan (*Bull. Ent. Res.*, **3**, pt. 4; 1947). It appears that most of the southern half of the Sudan is a yellow fever area in the sense that people immune to the disease have been found in many parts of that territory. The chance of the disease spreading to parts hitherto free is liable to be increased by such outbreaks as the great Nuba Mountains epidemic of 1941. It is noteworthy that several towns in the Sudan lie on important air, rail and water routes leading to countries free from yellow fever. Some 140 species of mosquitoes are known from the Sudan, and, of these, twelve kinds are known to be capable of transmitting the yellow fever virus, while several other kinds are suspected in this connexion. Two further species are able to retain this virus throughout life without apparently possessing the ability to transmit the disease by their blood-sucking habits. The object of the present paper is to record information on the occurrence and distribution of mosquitoes in the Sudan. The Anophelines are only briefly considered because they are unlikely to transmit yellow fever. Among the Culicines that affect man and frequent human habitations, *Aedes taylori* is believed to be one of the chief vectors in the case of the Nuba Mountains epidemic. As regards *Aedes ægypti*, it appears that mosquito control measures have had the effect of rendering urban yellow fever epidemics, carried by this species, virtually impossible, and the disease has been exterminated from Khartoum. The relation of *Tæniorhynchus africanus* to the disease is of special interest owing to its wide range and abundance in the Sudan. While there is no evidence that this species can act as a vector, it seems likely that it can act in this way in limited epidemics about the Upper Nile area. The author concludes by discussing the measures of mosquito control in the Sudan, which greatly restrict the possibilities of the spread of yellow fever. At the same time it is evident that the control of a rural epidemic would be difficult to achieve.

University of London Appointments

The following appointments have been announced by the University of London: Mr. E. H. Phelps Brown, University lecturer in economics at Oxford, to the University chair of economics of labour tenable at the London School of Economics as from October 1; Dr. Harold Burton, senior lecturer in organic chemistry at the University of Leeds, to the University chair of chemistry tenable at King's College of Household and Social Science as from October 1; Mr. P. T. Bauer, lecturer in economics at the London School of Economics and Political Science, to the University readership in agricultural economics tenable at the School, as from October 1; Mr. R. H. Coase, lecturer in economics at the London School of Economics and Political Science since 1938, to the University readership in economics tenable at the School as from October 1; Dr. P. C. C. Garnham, senior parasitologist in charge of the Division of Insect-borne Diseases in the East African Medical Service, to the University readership in medical parasitology tenable at the London School of Hygiene and Tropical Medicine; Mr. J. W. H. King, senior lecturer in civil engineering at University College, Nottingham, to the University readership in civil engineering tenable at Queen Mary College as from October 1. Dr. M. M. Loève, lecturer at Birkbeck College, to the University readership in applied mathematics tenable at Birkbeck College as from October 1; Dr. F. T. G. Prunty, lecturer in chemical pathology at St. Thomas's Hospital Medical School, to the University readership in chemical pathology tenable at the School as from October 1; Dr. Richard Rado, lecturer in mathematics in the University of Sheffield, to the University readership in pure mathematics tenable at King's College as from October 1; Dr. F. R. Selbie, assistant pathologist at the Bland-Sutton Institute of Pathology, to the University readership in bacteriology tenable at Middlesex Hospital Medical School as from October 1.

The title of professor of zoology in the University has been conferred on Dr. Alastair Graham, in respect of the post held by him at Birkbeck College; the title of professor of zoology in the University has been conferred on Dr. A. J. Grove, in respect of the post held by him at Queen Mary College; the title of reader in pure mathematics in the University has been conferred on Dr. R. G. Cooke, in respect of the post held by him at Birkbeck College; the title of reader in civil engineering in the University has been conferred on Dr. S. R. Sparkes, in respect of the post held by him at the Imperial College of Science and Technology.

The degree of doctor of science has been conferred on Prof. E. J. King, professor of pathological chemistry at the Postgraduate Medical School.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Elementary Isotopic Analysis: Determination of Nitrogen

WE have recently described an isotopic method for the determination of oxygen[1] and carbon[2] in organic compounds by using heavy oxygen (O^{18}) and carbon (C^{13}) respectively in conjunction with a mass spectrometer. Using the same method, higher precision is possible in the determination of nitrogen and hydrogen, since N^{15} and H^2 (deuterium) are available in higher concentrations (30–35 per cent for N^{15}) than the oxygen isotope (1·2 per cent) and the carbon isotope (10–20 per cent).

In order to extend this method to nitrogen, we have made the following four determinations. Representatives of two types of compounds, heterocyclic and nitro, were chosen in view of the well-known difficulties of analysing them by the standard Kjeldahl method. The compounds used were pyridine ($n^D_{20} = 1{\cdot}5090$) and nitroethane ($n^D_{20} = 1{\cdot}3912$).

A known weight of substance (a) was burned simultaneously with a known weight (b) of pure isotopic $N^{15}H_3$ in a quartz tube, in the presence of an excess of copper oxide, copper and platinum wire, for 45–60 minutes. (Copper and platinum were inserted, of course, to reduce and equilibrate any oxides of nitrogen.) Both the pyridine and the nitroethane were burned at 750° C. The percentage of nitrogen (x) was calculated from our usual formula: $x = 100\,b(m - n)/an$, where m and n are, respectively, the initial and the final percentage excess of N^{15} in the ammonia and nitrogen.

Any air leakage into the sample, either during the run or during analysis, can be corrected for by calculating the air nitrogen contribution from the argon (mass = 40) peak. In a good determination the air nitrogen should be less than 3 per cent of the total nitrogen.

The results obtained are as follows:

	Pyridine, C_5H_5N		Nitroethane, $C_2H_5.NO_2$	
Analysis	1	2	3	4
a, mgm. substance	25·56	30·02	25·04	16·97
b, mgm. N_2, added as NH_3 (using normal at. wt. of N = 14·008)	$1{\cdot}79_5$	4·27	4·43	3·43
m, % excess of N^{15} above normal (= 0·76%) in b	34·84	34·84	32·10	32·10
N^{15} content of equilibrium mixture (%)	10·52 10·59	16·30 16·18	16·50 16·38 16·34	17·55 17·54 17·47 17·43 17·56
Average	10·55±0·04	16·24±0·13	16·41±0·06	17·51±0·05
n, average % excess of N^{15} in equilibrium mixture	9·79	15·48	15·65	16·76
% N in substance, experimental	17·96±0·09	17·79±0·26	18·60±0·14	18·52±0·13
% N, theoretical	17·74	17·74	18·66	18·66

The mean probable deviation from the theoretical value is 0·4 per cent of the nitrogen content; it is within the accuracy and precision of the Consolidated Engineering Corporation's mass spectrograph that we used.

A detailed description of our experiments will be published later.

Difficulties are encountered in the determination of *hydrogen* by this method because of wide differences in the rates of diffusion of protium and deuterium. Additional precise calibrations or changes in the construction of the present mass spectrographs would be necessary before our method can be successfully applied.

We are indebted to Dr. D. Rittenberg of Columbia University for the sample of $N^{15}H_3$ used.

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April 9.

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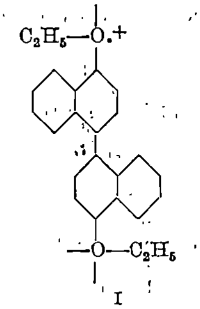
[1] Grosse, A. V., Hindin, S. G., and Kirshenbaum, A. D., *J. Amer. Chem. Soc.*, 68, 2119 (1946).

[2] Grosse, A. V., Kirshenbaum, A. D., and Hindin, S. G., *Science*, 105, 101 (1947).

A Semi-Quinonoid Oxidation Product of 4 : 4-Diethoxydinaphthyl

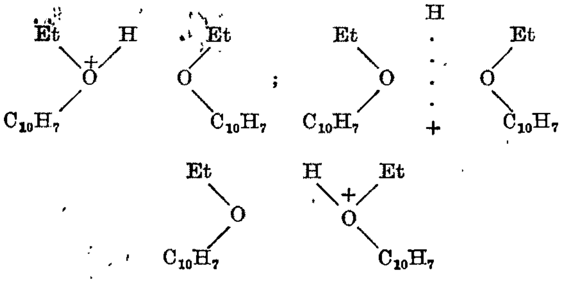
THE communication from Messrs. Hughes, Hush and Mellor[1] reporting a green oxidation product of tetramethyl-benzidine and the projected extension of work to related compounds renders desirable some account of our own work on the green colour instantly developed when 4 : 4′-diethoxydinaphthyl is dissolved in a large excess of concentrated sulphuric acid. The increase of intensity of absorption (measured at 660 mμ) is linear with that of concentration of the dinaphthyl until this reaches c. 310 mgm./litre. The solubility of oxygen in sulphuric acid being 33 mgm./litre[2], calculation shows the green colour to arise from the action of c. 8 gm. oxygen per gm. mol. diethoxydinaphthyl. A similar result follows if selenium dioxide or nitrous acid be used to intensify the colour. We therefore attribute the structure I to the green product.



I

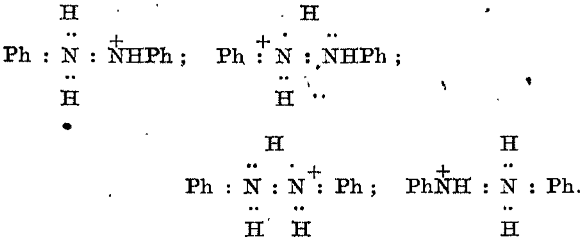
We expect to find that the blue, green and red colours developed by oxidation of diphenol[3], 3 : 3′-dimethyl-4 : 4′-dinaphthol[4], and dianthranol[5] respectively are of the same semi-quinonoid character and will develop in excess of sulphuric acid without further addition of an oxidizing agent.

So far we have been less concerned with isolation of the semiquinonoid product (I) than with the general significance of the facts that: (1) the green colour is destroyed on addition of 1-ethoxynaphthalene, which is itself then converted to 4 : 4′-diethoxydinaphthyl; (2) 1-ethoxynaphthalene itself causes the development of the same green colouring matter in excess of sulphuric acid, but in this case only gradually. Nitric acid, aliphatic and aromatic nitro-compounds, bromine and selenium dioxide all promote the same reaction. Further, aluminium chloride is also effective[6] as a substitute for sulphuric acid, so that the reaction obviously depends on proton activation. This, however, does not involve formation of a naphthylethyloxonium ion, because the ethoxy group survives the oxidation intact, and we must, therefore, be concerned here with an example of protonic disturbance[7], which causes an electronic deficiency on the oxygen atom, in turn made good by a contribution from the oxygen atom of another molecule of 1-ethoxynaphthalene. The resulting complex is responsible for the *red* colour, which is produced when 1-ethoxynaphthalene is dissolved in a small amount of sulphuric acid and fades as the mixture sets to a solid mass of the sulphonic acid. A very similar, if not identical, colour is formed on the addition of aluminium chloride to the ethoxy derivative, and reaches a maximum intensity when the molecular proportions of chloride and ethoxy compound are as 1 : 2. The complex is perhaps best formulated as a resonance hybrid of the three forms :



II

The stages by which this furnishes diethoxydinaphthyl are analogous to those by which the hydrazobenzene-proton complex (which we represent as the hybrid III) yields benzidine[8]. Indeed, Sir Robert Robinson has already adumbrated a connexion between the two types of reaction[8].



III

Parallel with the formation of benzidine there is frequently a decomposition of the hydrazobenzene to azo-derivative and amine. This reaction is specially favoured when the normal benzidine change is hindered or inhibited by 4 : 4′-disubstitution of the hydrazobenzene[9]. It appears not to have been realized that the reaction is exactly comparable with the oxidative splitting of the nitrosomethylaniline-proton complex studied by Jones and Kenner[8]. In more modern form, the correspondence between the two may be exhibited as follows :

$$[\mathrm{PhNHMe}\ \overset{+}{\mathrm{N}}\mathrm{O}] + e \rightarrow \mathrm{PhNHMe} + \mathrm{NO}$$

IV

$$[\mathrm{PhNH_2}\ \overset{+}{\mathrm{N}}\mathrm{HPh}] + \mathrm{PhNH\,.\,NHPh}.$$
$$\rightarrow \mathrm{PhNH_2} + \mathrm{PhNH_2} + \mathrm{Ph\dot{N}} = \mathrm{NPh} + \mathrm{H}^{\cdot}$$

V

Thus, whereas the benzidine change is one in which electronic flow to one or other of the nitrogen atoms is intramolecular, it is intermolecular in the cases just mentioned. A complete description of the relevant proton-complexes in these instances would include, in addition to IV and V, radical forms as in II and III, and such forms were particularized by Jones and Kenner in their paper as operating "within the sphere of each other's action". Any discussion as to whether in this condition, which later was included in the conception of "the transition state", it is homolysis or heterolysis which occurs, is naturally devoid of significance.

Competitive reaction in promoting respectively exchange and substitution processes of proton or other kation, for example, nitronium ions, or nucleophilic reagents, with 1-ethoxy-naphthalene (or, indeed, any benzenoid compound) is, of course, subject to the usual regulative principles. Thus we find nitronium ion in concentrated sulphuric acid solution merely assisting the oxidative process already described as ensuing from proton attack, but very largely, if not exclusively, nitrating in 65 per cent sulphuric acid solution, in which protons are sufficiently diverted to hydroxonium ion formation, and the oxidative process does not occur. The observations of Martinsen[11] on the kinetics of nitration are also to be regarded in this manner rather than as attributable simply to the need for SO_4H' ions as acceptors of displaced protons[12].

Finally, this parallelism between the action of proton and nucleophilic reagents in substitution, coupled with the participation of radical forms in such complexes as II and III, supports the postulation of an analogous transition state, previously described by one of us and invoked to explain the formation of phenol[13] and other products, which frequently accompanies nitration. In fact, it is not too much to say that this general point of view pervades the above co-ordination of a wide range of phenomena.

A fuller account of this work, which will be extended, will be published in due course.

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May 9.

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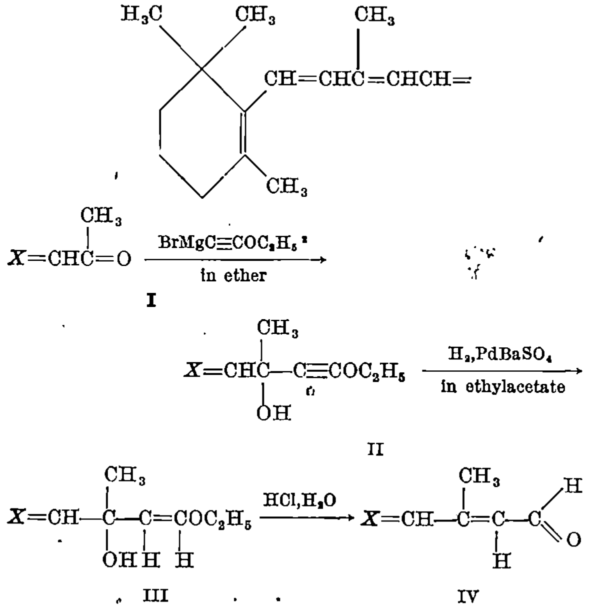
[12] Compare Hughes, Ingold and Reed, *Nature*, **158**, 488 (1946).
[13] Kenner, *Nature*, **156**, 369 (1945).

Synthesis of Vitamin A Aldehyde

In our communication in *Nature*, regarding the synthesis of vitamin A acid[1], we stated that "in the course of these investigations we received valuable assistance from Dr. H. H. Inhoffen, who suggested several other approaches to the problems". We have in the meantime learned that Dr. Inhoffen, who is now professor of organic chemistry in Brunswick, feels that the wording of this acknowledgment may give rise to misunderstanding. We therefore wish to point out that in the course of the occupation during the War, Dr. Inhoffen superintended and directed our work on the synthesis of vitamin A acid and vitamin A, and his advice was of great help in our work. When communications between Germany and the Netherlands were broken, joint publication could not be envisaged. We therefore had to single out that part of the work which we thought we could claim in good faith to be based mainly on our own ideas. This we have done to the best of our abilities. After our contact with Dr. Inhoffen ended in September 1944, we pursued the work along new lines and now present further results.

We have prepared vitamin A aldehyde from the C_{18} ketone I[1], as indicated in the following scheme. Writing X for



I

II

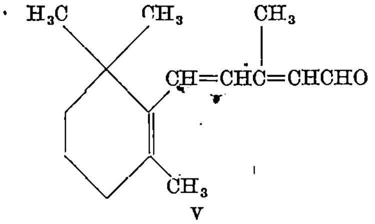
III

IV

The aldehyde was characterized as its crystalline semicarbazone, m.p. 207–209° with decomposition. The absorption spectrum exhibits a well-defined maximum at 3750 A., log $E_{\max} = 4{\cdot}87$. This corresponds with the absorption spectrum of the vitamin A aldehyde oxime[3] obtained by Hunter and Hawkins from natural vitamin A. With antimony trichloride in chloroform a very dilute solution of the semicarbazone in chloroform produces a purple-red colour; with a more concentrated solution the colour is blue-violet.

As the reduction of vitamin A aldehyde, obtained from natural vitamin A, has been previously described[4], a total synthesis of vitamin A now seems to be possible. We intend to synthesize vitamin A_2-aldehyde and vitamin A_3 according to the same scheme, starting from the C_{18}-ketone, derived from pseudo-ionone.

From β-ionone and ethoxyethynylmagnesium bromide we obtain, after an analogous series of reactions to those described above, β-ionylidene acetaldehyde V, identical in all respects with the substance described by Kuhn and Morris[5]. The absorption spectrum of the semicarbazone (m.p. 193–195°) had a single well-defined maximum at 3230 A.



V

With this substance we propose repeating the much discussed synthesis of vitamin A by Kuhn and Morris.

Our thanks are due to the Board of N. V. Organon for permission to publish this paper.

Note added in proof. In the meantime, we reduced the vitamin A aldehyde by means of aluminium-isopropoxide and isopropyl alcohol. After chromatography we obtained an oily fraction containing about 35 per cent of vitamin A according to its absorption spectrum and its biological activity. Further proof was obtained by conversion into anhydro vitamin A.

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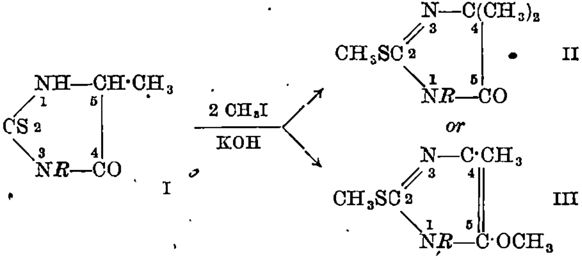
Reported Preparation of Mercaptoimidazole Derivatives by Methylation of 3 : 5-Disubstituted Thiohydantoins

In the examination of the ultra-violet absorption spectra of a number of methylated thiohydantoins, anomalous results were obtained if the structures previously assigned to the methylation products were accepted.



I

II

III

acid $\lambda_{\max.}$ 2330 A.
$\epsilon_{\max.}$ 20,000.
alkali $\lambda\sim$ 2,360-2,420 A.
$\epsilon\sim$ 4,500.
II, R = CH_3.

Thiohydantoins derived from alanine, for example, 2-thio-3 : 5-dimethylhydantoin (I, R=CH_3), methylate readily, two methyl groups being introduced into the molecule. Two products are possible (II and III), and Marckwald, Neumark and Stelzner[1] assigned structure III to the resulting derivative. Examination of the ultra-violet absorption spectra of the compound produced by the introduction of two methyl groups into 2-thio-3 : 5-dimethylhydantoin showed that this was unlikely to be correct. The spectra of this compound under differing conditions of *p*H were, in fact, identical with those shown under the same respective conditions by 1 : 4 : 4′-trimethyl - 2 - mercapto - 5 - ketodihydroimidazole (II, R=CH_3, prepared by the introduction of a single methyl group into 2-thio-3 : 5 : 5′-trimethylhydantoin). If structure III were correct, the conjugated double-bond system should show a spectrum markedly different from that shown by structure II.

Attention was then given to the compounds themselves. The methylated derivatives were bases, oily, and difficult to crystallize, and differing reports are available[2,3] of their properties and physical constants. Methylation products of a number of 2-thio-3-*R*-5-methylhydantoins and 2-thio-3-*R*-5 : 5′-dimethylhydantoins have now been prepared (*R* = methyl, phenyl and *o*-tolyl), and in each case the products of methylation from the two sources were found to be identical. As an example, the sulphate of 1 : 4 : 4′-trimethyl - 2 - mercapto - 5 - ketodihydroimidazole (prepared by monomethylation of 2-thio-3 : 5 : 5′-trimethylhydantoin) melted at 190–191° C.; the sulphate of the base produced by dimethylation of 2-thio-3 : 5-dimethylhydantoin also melted at 190–191° C., and there was no lowering in melting point on mixing the sulphates of the two bases.

It is obvious, therefore, that mercaptoimidazole derivatives (III) are not produced by dimethylation of 2-thio-3-*R*-5-methylhydantoins, the resulting products being 1-*R*-2-methylmercapto-4 : 4′-dimethyl-5-ketodihydroimidazoles (II).

A comprehensive account of this work will be submitted for publication at a later date.

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Chemical Constitution of Keratin

WOOL fibres show histological structure when examined microscopically, and this structural heterogeneity has recently been shown in greater detail by the electron microscope[1,2,3]. Apart from some analyses on scale substance by Geiger[4], little chemical evidence on the composition of the different histological components is available. Recently, I have found that wool which has been deamidated by treatment with cetyl sulphonic acid[5] (0·05 *M*, 65°, 6½ days) will partially disperse if stirred in dilute alkali (*p*H *c.* 11, room temperature, overnight), leaving a suspension of the resistant residues of the scales and cortical cells. When the clear alkaline supernatant liquor is acidified to *p*H 4–5, a protein-like material is precipitated which is soluble in either dilute acid or alkali. A fairly complete amino-acid analysis of these components has been carried out and is given in the accompanying table together with data for the intact wool from which they were derived. *A* is the resistant component of the scales and cortical cells, *B* is the portion precipitated from the alkaline liquor, while *Aa* is the resistant residue from retreatment of part of *A* with cetyl sulphonic acid followed by dilute alkali. These analyses show quite clearly a great difference in amino-acid composition between *A* and *B* and the intact wool. The general tendency is for amino-acids of high molecular weight to be concentrated in the soluble component, while the resistant component is particularly rich in cystine and proline. The results thus show great similarities to those of Geiger[4], who probably analysed the resistant component of the scales.

AMINO-ACID COMPOSITION OF WOOL AND COMPONENTS SEPARATED FROM IT. (NITROGEN AS % TOTAL NITROGEN)

	Untreated wool	*A*	*Aa*	*B*
Total nitrogen	16·9	15·4	14·5	13·4*
Total sulphur	3·76	6·16	7·51	4·25*
Cystine	8·0	15·0	20·3	5·2
Phenylalanine	1·9	1·0	0·7	1·7
Leucine	6·7	5·3	3·6	9·2
Valine	3·6	3·9	3·5	4·0
Proline	3·8	6·7	7·6	1·0
Tyrosine	2·6	1·4	1·3	2·0
Alanine	3·2	4·2	3·3	4·0
Arginine	20·0	17·3	15·5	—
Hydroxamino-acids	12·8	14·0	—	—

* Not corrected for bound cetyl sulphonic acid.

Are these different components hydrolytic products of one keratin, or do they represent two keratins? The homogeneous protein insulin has been shown to give a cystine-rich fraction on enzymic digestion[6], and a similar effect has been noted with casein[7]. Moreover, Gordon, Martin and Synge[8] found that proline peptides of gelatin were especially resistant to hydrolysis, although in a later study of the partial hydrolysis products of gramicidin-S the only theoretically possible dipeptide which was not detected was prolyl-valine[9]. Fischer and Abderhalden[10] also found that prolonged enzymic digestion did not liberate free proline from casein, edestin, hæmoglobin, serum globulin, egg albumin or fibrin.

On the other hand, *A* and *Aa* possess recognizable histological structure pointing very strongly to the separation of different keratins pre-existent in the wool fibre. *A* and *Aa* may correspond to the fibrillar component and *B* the matrix substance of wool separated by Rees and Mercer[1,2,3]. Due to the courtesy of Prof. W. T. Astbury, the component *Aa* has been examined under the electron microscope. It is composed of fibrils which Mercer[11] considers to be very similar to the fibrillar component isolated by him. A possible mechanism for the separation of the two components by the present procedure is that deamidation of the matrix component renders it soluble in dilute alkali: a possible analogy for this is provided by the conversion of collagen to gelatin, which is also accompanied by a loss of amide-nitrogen.

If wool consists of more than one kind of keratin, the analytical data of the table throw grave doubt on any theory of wool structure based on correlations between X-ray data and chemical analyses of whole wool. Moreover, the occurrence of such a high percentage of proline residues in the fibrillar component suggests that Astbury's structure for keratin[12] requires modification to include the extensive folding of the chains which these residues cause[13,14]. The high proline and cystine content of the resistant components *A* and *Aa* may have special significance. For example, at least part of the (*C* + *D*) fraction[15] of the combined cystine may owe its inertness to neighbouring proline residues, a suggestion which accords well with the previous hypothesis of the mode of linkage of this portion of the cystine[16].

An attempt to isolate cystine peptides from the $(C + D)$ fraction of the combined cystine of wool is now in progress, and together with full details of the work referred to will be published elsewhere.

Note added in proof. Preliminary qualitative examination of cystine peptides from the $(C + D)$ fraction of whole wool has confirmed the suggestion that proline is associated with this fraction. Glycine, alanine, serine and threonine seem also to be present in substantial amounts.

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[2] Mercer and Rees, *Austral. J. Exp. Biol.*, **24**, 175 (1946).

[3] Farrant, Mercer and Rees, *Nature*, **159**, 535 (1947).

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Application of the Cathode Ray Oscillograph to Measurements of Short Life-Periods of Radioactive Sources

THE most accurate determinations of the life-periods of short-lived radioactive nuclei have been made using either coincidence circuits with variable resolving times[1], or the method of delayed coincidences[2].

Recent developments in cathode ray oscillographs have enabled measurements of this sort to be made in a more direct manner and with standard equipment. In this method, a pulse from one Geiger-Müller counter starts the single sweep on the oscillograph, and the output from a second counter is applied to the vertical plates. If these pulses are due to the radiations from a single radioactive source of short life, then observations on the distribution of the pulses seen on the screen enable an estimate of the half-life of the source to be made.

The method has been applied to the transformation

$$\text{radium C} \xrightarrow{\beta} \text{radium C}' \xrightarrow{\alpha} \text{radium D}.$$

The β-ray from radium C is followed, after a short time-interval, by the emission of an α-ray from the daughter nucleus, radium C′. Observations on these time intervals enable the half-life of radium C′ to be estimated.

A thin-walled vessel containing radon gas was placed between two Geiger-Müller counters. One counter had a window of thickness sufficient to prevent α-particles and most of the β-particles from radium B being recorded. The other counter was operated in the proportional region so that it responded to α-particles only. The stopping power of the window of this counter was such that only radium C′ α-rays could penetrate.

The pulses from the counters were fed through suitable circuits to the oscilloscope, the β-counter initiating the sweep and the α-pulses being applied to the vertical deflexion plates. The instrument used was an Ultrascope, Mark 6, with three speed-ranges, namely, 25, 50 and 500 microsec. Incorporated in the time-base is a calibrating device consisting of an oscillatory circuit 'ringing' at a known frequency. The output of this causes the trace to be intersected by dark gaps representing known time-intervals. Hence visual observation of the pulses enabled their distribution in time to be recorded. Many of the pulses, of course, appear on the screen by chance, and it is necessary to perform control experiments in which the counters are irradiated by separate sources to allow for this.

The corrected distribution in time of the α-pulses shows an exponential fall giving a half-value period for radium C′ of 140 microsec. This result is not so accurate as that claimed for coincidence methods[1,3], but it is thought that the method is capable of being developed for the measurements of much shorter periods, in particular the life-time of metastable states which are of considerable interest theoretically.

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Constitution of Alkali Halide-Borate Glasses

Majumdar, Banerjee and Banerjee claim to have demonstrated[1] that sodium chloride dissolved in borax glass was present in the form of crystallites, and also that sodium chloride–boric oxide glasses gave the X-ray diffraction pattern of sodium chloride (together with some unidentified lines). The experimental work and deductions therefrom demand some comment and criticism.

There can be no objection to the experimental results obtained with the halide–borax glasses, since it has been shown that, in such systems as Na_2O—SiO_2 [2], Na_2O—B_2O_3 [3], there is an upper limit to the amount of alkali metal oxide which can exist in the vitreous phase. I have found the same type of phenomenon to occur with the systems CaO—B_2O_3, Na_2O—CaO—B_2O_3, RX—B_2O_3 (where R is Li, Na or K, and X is F, Cl, Br or I) and Na_2O—RX—B_2O_3. Thus a molten mixture of sodium carbonate and silica, in proportions to yield an $Na_2O : SiO_2$ ratio greater than that approximating to the metasilicate, $Na_2O.SiO_2$, separates into two phases on cooling. The crystalline phase, in a vitreous matrix, consists of impure sodium carbonate, probably a double salt of the carbonato-silicate type.

In binary borate systems, the limiting proportions for glass formation approximate to the compositions, for example, $Na_2O.2B_2O_3$ (that is, anhydrous borax), $NaF.2B_2O_3$ and $NaCl.3B_2O_3$. The precipitation of excess alkali compound is particularly well marked in the KF—B_2O_3 system, where a melt containing potassium fluoride, in excess of the limiting theoretical composition $3KF.2B_2O_3$, on cooling can produce very well-developed crystals of the halide up to 3 mm. in size.

The fact, therefore, that melts of borax and sodium chloride yield products which give the X-ray diffraction pattern of the alkali halide is not unexpected.

The glassy matrix itself, however, does not give a well-defined pattern, since it is a true glass, and the alkali halide in this vitreous phase is a part of the random structural arrangement. A complete discussion of the theory of the participation of fluorides and other compounds in the glass network will soon be published elsewhere. I wish, however, to dispute the general statement that alkali halides dissolved in glass are present as crystallites.

With regard to the halide – boric oxide systems, I have found no evidence for the presence of a crystalline phase except when, as stated above, the amount of halide was greater than the particular limiting composition of the system.

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Determination of Bilirubin in the Umbilical Blood as an Aid in the Early Diagnosis of Hæmolytic Disease in the Newborn

The bilirubin content of the blood is increased in hæmolytic conditions, as can be demonstrated by the indirect quantitative reaction of Van den Bergh. It seems probable, therefore, that the presence in the umbilical circulation of increased bilirubin, demonstrated by the indirect reaction, might be interpreted as early diagnostic evidence of hæmolytic disease of the newborn.

The bilirubin content of fœtal blood is not dependent on bilirubin of maternal origin, since bilirubin does not pass through the placental barrier[1]. The determination of the normal range of bilirubin in umbilical blood at birth is, however, extremely difficult, since this value varies widely and the fluctuations are associated with a series of factors[2].

In a series of 119 quantitative determinations of bilirubin in the umbilical blood by Van den Bergh's indirect method, we found values varying from traces to 3·6 mgm. per cent. Included in this series were only such cases in which both mother and fœtus were either *Rh*-positive or *Rh*-negative. In 42 of these cases, mother and fœtus had incompatible blood groups, so that immunization of the mother by fœtal erythrocytes was possible (for example, mother in group *A* and fœtus in group *B*, etc.). In this group of cases, 12 (28·5 per cent) had more than 2 mgm. per cent bilirubin in the umbilical blood.

In the remaining 77 cases, the mother and fœtus belonged to the same or to different but compatible blood groups (mother and fœtus both in group *A*, or mother in group *A* and fœtus in group *O*, etc.). In this group bilirubin in the umbilical blood exceeded 2 mgm. per cent in 9 cases (11·6 per cent).

A detailed report on the relationship between the bilirubin value in umbilical blood and the titre of maternal blood antibodies against fœtal erythrocytes will be reported elsewhere.

In 9 additional cases, the mothers were found to be *Rh*-negative, while their fœtuses were *Rh*-positive. In these cases there were from 0·8 to 2·4 mgm. per cent bilirubin in the umbilical blood. Congenital hæmolytic diseases of the newborn did not develop in any of them.

On the other hand, in three cases of *Rh*-negative mothers (two of whom had previously delivered at least one erythroblastotic fœtus) the bilirubin-levels in the umbilical blood were respectively 4·9, 8·1 and 6·2 mgm. per cent. Although the low titre of *Rh* antibodies (agglutinating, blocking and conglutinating) found in the maternal serum in these three cases seemed to indicate that no intensive immunization had taken place, all three newborn infants developed severe hæmolytic disease within 2–36 hours after delivery. Two of them, in whom the bilirubin values in the umbilical blood were 6·2 and 8·1 mgm. per cent respectively, died 38 and 96 hours after delivery. In the first case, the blood count made shortly before death was: erythrocytes 5,160,000 and Hb—17 (Sahli); and at autopsy, kernicterus was found. In the second, the blood count revealed: erythrocytes 1,360,000, Hb—6½ (Sahli). In both, the diagnosis of erythroblastosis fœtalis was confirmed at autopsy. The third (4·9 mgm. per cent of bilirubin in the umbilical blood) recovered from a very severe anæmia after repeated transfusions of *Rh*-negative blood.

Since jaundice and anæmia severe enough to cause death shortly after delivery may develop in infants apparently normal at birth, and since the antibody titre of the maternal blood did not always serve as an indication of the hæmolytic process in the fœtus, we consider a high value of bilirubin in the umbilical blood to be an indication of hæmolytic disease of the newborn. The presence of high bilirubin in the umbilical blood may, therefore, permit the early diagnosis of erythroblastosis fœtalis (anæmia neonatorum, icterus gravis and kernicterus).

These observations are considered to be preliminary, and a more extensive study is in progress.

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Relative Activities of *l*- and *dl*-Thyroxine

We have compared the biological activities of *l*- and *dl*-thyroxine in rats receiving 4-methyl-2-thiouracil by determining the 'thyroxine requirement' as defined by Griesbach and Purves[1]. This method consists of finding the amount of thyroxine which will prevent the pituitary basophil changes, resulting from the thyroxine deficiency produced by the blockage of thyroxine synthesis by the methyl thiouracil. The thyroxine samples used were: (1) *l*-thyroxine presented by Dr. C. R. Harington, and prepared by the iodination of *l*-di-iodothyronine[2]; (2) *l*-thyroxine presented by Dr. E. P. Reineke, and prepared by acid hydrolysis of iodinated casein[3]; (3) *l*-thyroxine prepared in this laboratory from *l*-di-iodotyrosine by the method of Harington and Pitt Rivers[4]; (4) *dl*-thyroxine presented by Burroughs Wellcome and Co., and prepared by alkaline hydrolysis of thyroid substance.

The 'thyroxine requirement' of the rat was found to be 2·3 micrograms of *dl*-thyroxine per 100 gm. per day. The equivalent value for *l*-thyroxine was 1·5 micrograms per 100 gm. per day, the same value being obtained for all three samples within the error of estimation, which we judge to be ± 5 per cent.

This gives a ratio of activities $l : dl = 1{\cdot}5 : 1{\cdot}0$; a result in conflict with the ratio of 2 : 1 found by Reineke and Turner[5], who estimated the amount of thyroxine necessary to prevent thyroid-weight changes in the thiouracil-treated rat.

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Autoradiography of Single Cells

The use of radioactive isotopes or tracers in the study of fundamental biological and biochemical problems has grown enormously during the last few years, and is likely to become still more important as larger quantities of various radioactive elements are made available. Certain types of problem can be solved by the application of well-known electrical methods to bulk tissue; it is recognized, however, that in any given tissue, individual cells may be in very different states or stages of development. For this reason the cytologist, in particular, wishes to study single cells. It is of interest to inquire, therefore, to what extent, if any, the photographic method of autoradiography can be applied to small organisms and single cells. It is clear from the work of Hamilton[1] and others that this technique is useful for large sections of tissue, but many other factors have to be taken into account when considering its applicability to single cells.

These factors may be stated quite simply, so long as we are only concerned with the question of detection in a given time. The problem of resolving power does not arise until conditions for detection have been proved favourable. In this note we are chiefly concerned with detection, and our calculations are based on existing data for radiophosphorus, P^{32}.

(1) *Radiophosphorus Supply.* A typical supply has an activity of 12 millicuries for a mass of 3·8 mgm. of phosphorus *immediately after irradiation.* Since 12 millicuries represent $12 \times 3{\cdot}7 \times 10^7$ disintegrations/sec., and the decay constant of P^{32} is $5{\cdot}6 \times 10^{-7}$ sec.$^{-1}$, it can easily be shown that the ratio of atoms P^{32}/P^{31} is $1 : 10^5$.

(2) *Phosphorus Content of Tissue and its Activity.* Marshak[2] has given results for the uptake of radiophosphorus by lymphoma and liver cells of mice. Our calculations are based on the values of P^{32} uptake for lymphoma cells two days after injection, when the uptake for lymphoma nuclei was greatest. On the whole, the activities of liver cells were less than those of lymphoma.

For lymphoma cells the uptake was found to be 4 per cent of the injected dose per gm. of tissue. This corresponds to an uptake of P^{32} of 0·4 per cent by weight of the total phosphorus present in the cell. The activity of the radiophosphorus supply mentioned in (1) is one hundred times the activity of that used by Marshak[2]. Using Marshak's figures, and making allowance for this fact, it can be shown that the activity of 1 gm. of tissue is 40 μc.

Suppose now that a layer of tissue one cell thick is to be autoradiographed, and that the cell has a thickness of 10 μ: the volume of cells presented to 1 sq. mm. of a photographic plate is then 10^{-5} c.c. For an activity of 40 μC./c.c. (the density of tissue is approximately unity), the activity per sq. mm. of plate is 0·4 millimicrocurie (mμC.).

(3) *Detection.* Lindsay and Craig[3], who have carried out P^{32} uptake experiments on larvæ and obtained uptakes similar to those of Marshak, mention that for X-ray film an exposure equivalent to 50 mμC./mm.^{2} was required for 1 minute. This figure has been confirmed by us in experiments using Industrex Type *D* X-ray film (Kodak) on the detection of drops of radiophosphorus solution (1 mμC. was detected and gave blackening sufficient for microphotometer measurements in 50 min.). Thus, with X-ray film an activity of 0·4 mμC./mm.^{2} would require a 2-hour exposure.

While we are here chiefly concerned with the problem of detection, the question of resolution cannot entirely be avoided, since the choice of the photographic plate is one of the determining factors. Assuming the linear dimensions of the cell to be of the order of 10 μ, a resolving power of at least 100 lines per mm. is desirable. Such plates (for example, Kodak *B*5 and *B*10) have about 1/50 of the speed of Industrex X-ray film. On this basis, an activity of 0·4 mμC./mm.^{2} would require an exposure of 4 days. The activity of the phosphorus used by Marshak (*loc. cit.*) was 1/100 of this figure, and the exposure required would, therefore, be about 40 days.

In order to make the autoradiographic technique a practicable one, a safety factor of at least 10 should be introduced to allow for (*a*) the decay of the phosphorus activity during the period of exposure, and (*b*) a certain degree of contrast in the picture to show the required detail; this, however, depends on the variation of concentration of P^{32} throughout the cell.

(4) *Conclusion.* The autoradiography of single cells having activities equal to those obtained by previous authors in experiments on bulk tissue is clearly impossible. Similar experiments carried out with more active radiophosphorus having a ratio of $\frac{\text{No. of atoms of } P^{32}}{\text{No. of atoms of } P^{31}} = \frac{1}{10^5}$, however, and using reasonably fine-grain plates, seem to be just possible. Since the possibility could only be realized in exposures lasting a few days, it is unlikely that autoradiographic techniques can be used to study migration of radioactive isotopes in single cells.

Autoradiographs should, however, be obtainable after a few hours exposure if (*a*) uptakes can be increased above the figure of 0·4 per cent, possibly by a series of injections lasting several days, or (*b*) the concentration of P^{32} in the sample of active phosphorus can be increased. Any improvements in the speed of photographic plates which may arise would also improve the possibilities of carrying out such experiments. There are obvious difficulties in maintaining biological material in a suitable condition for the long periods suggested by our calculations; moreover, no account has been taken of the biological effects of the β-radiation. Chromosomal aberrations, such as breaks and fragmentation, can readily be produced in root-tips growing in nutrient solutions containing radiophosphorus (as Miss M. Preston has recently shown in this laboratory). There are doubtless other effects; there is little point in discussing the biological implications of an experiment which on physical grounds is possible, but scarcely practicable at the present time.

I wish to thank Prof. J. T. Randall and Dr. M. H. F. Wilkins for valuable discussions.

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May 16.

[1] Hamilton, J. G., *J. Appl. Phys.*, 12, 440 (1941).

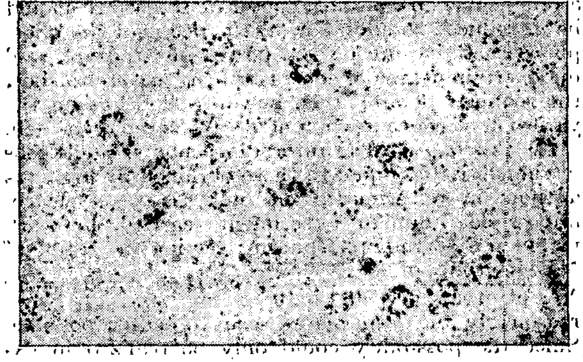
[2] Marshak, A., *J. Gen. Phys.*, 25, 275 (1941).

[3] Lindsay, E., and Craig, R., *Ann. Ent. Soc. Amer.*, 35, 50 (1942).

Osmophilic Granules in Chromatolytic Nerve Cells

W. A. STOTLER demonstrated at the sixtieth annual meeting of the American Association of Anatomists osmophilic granules in chromatolytic nerve cells; an account of this has been published[1]. This interesting finding is in agreement with our observations during the past few years[2]; that when using the Marchi reaction for degenerated fibres not only the degenerating myelin can be shown by the Swank–Davenport method, but also fine black granules in certain nerve cells.

Further experiments on this point strongly suggest that such a cell is one in which the metabolic processes are interfered with by cutting at some distant point its axon or its terminations. If this could be confirmed by other workers on the central nervous system, a valuable additional method of identifying interconnexions within the central nervous system would be available.



I illustrate my point by a photograph of several nerve cells of the lateral thalamic nucleus showing the black granules arranged in a ring-like formation around the cell nucleus. In this particular experiment, the motor cortex was removed on June 1, 1944, and the rabbit was killed on June 6, 1944; and in this instance the changes in the thalamus were shown after a short interval between the operation and death, while in other instances these changes could be seen even after a considerable period of time.

I should like to emphasize also that the large motor cells of cranial nerve nuclei contain after a certain interval of time chromophile granules after extensive cortical damage. This obviously cannot be explained by chromatolytic changes, and an explanation of this particular phenomenon has yet to be found.

P. GLEES

University Laboratory of Physiology,
Oxford. May 19.

[1] *Anat. Rec.*, 97, 426 (1947).

[2] Following my paper, *Brain*, 66, 229 (1943).

Introduction of a Beetle from Trinidad into Mauritius to Control *l'herbe Condé* (*Cordia macrostachya*)

IN all periods of human history, inadvertently or deliberately, man has introduced plants or animals of one country into another. In some cases the consequence has been tragic, but in others his action has achieved the desired result. In the later Middle Ages the Arabs introduced into Europe many vegetables, some of which have become established; spinach, for example. In the sixteenth century the Portuguese introduced many plants and animals from the Old World to the New and *vice versa*. In modern times, however, these introductions have been for a different purpose, frequently described as 'biological control'; by which is meant that man can use a natural enemy of an organism to cause its destruction for him. But this method has not always been successful because not all the factors that are involved in such transfers from one place to another are known, and, perhaps, not all of them can be completely known. But, so far as they can be known, they ought to be taken into consideration.

My attention has been directed to the fact that a batch of *Physonota alutacea* Boheman (Cassidinæ, Coleoptera) has been recently introduced into Mauritius; which, it is hoped, will eat *l'herbe Condé*—*Cordia macrostachya*, Roem. and Schult.—to such an extent that its unimpeded propagation will be checked. It should be remembered that this plant itself has been accidentally introduced into Mauritius.

Physonota alutacea Boheman occurs in Mexico, Central America, Venezuela, Colombia and Ecuador. It has also been found in San Francisco, Trinidad and the Galapagos Isles.

Physonota and other related genera belong to the New World and do not occur in the Old World. The Old World genus which is equivalent to *Physonota* is *Aspidomorpha*, and this does not occur at all in the New World. *Physonota* and its allies correspond to *Aspidomorpha* and its allies in general structure and habits so remarkably that one cannot help feeling that they must have descended from a common ancestor. From this relationship I assume that whatever food habits one group may have the other group probably will have.

The cassidine beetles have been known to eat plants of 26 out of 320 families as shown in the tables of my book (not yet published); the greatest number occurring on the Convolvulaceæ and the Compositæ. The beetles of the genus *Physonota* actually eat the following plants—Compositæ: *Helianthus* (sunflower), *Sonchus* (sowthistle); Boraginaceæ: *Cordia macrostachya*. In addition to *Physonota*, other New World cassidine beetles (*Coptocycla adamantica* Germer and *Cistudinella obducta* Boheman) have also been found on *Cordia*. It is important to remember this, since it means that if one species shows a taste for *Cordia* there are others which will have the same taste.

In the Convolvulaceæ the genera most attacked by cassidine beetles are *Convolvulus* and *Ipomœa* (sweet potato), and both Old and New World species of the Cassidinæ have been found on them. Therefore, although *Physonota* has not been actually found on the plants of these two genera, it is quite probable that *Physonota* will eat them.

The Old World genus *Aspidomorpha* occurs on *Argyreia* and *Quamoclit*—two genera also of the Convolvulaceæ. Three species of *Chelymorpha*, a New World genus allied to *Physonota*, have been found on three species of *Solanum* (Solanaceæ), including the potato. Three species belonging to two other genera of the New World have also been known to eat plants of *Solanum*. It seems likely, therefore, that *Physonota*, too, may feed on *Ipomœa* and *Solanum* as well as on *Cordia*.

Among the Gramineæ, both *Zea Mays* and *Saccharum* (sugar-cane) are attacked by *Chelymorpha*, the former also by a species of *Cassida*, a genus occurring in both New and Old Worlds; *Chirida*, another New World cassidine genus, also feeds on sugar-cane.

It is important to note that *Chelymorpha*, closely related to *Physonota*, has at least one species which is capable of eating the sugar-cane plant, and it is in the sugar-cane plantations that *Cordia* has become a nuisance. It is hoped that the introduced *Physonota* will behave as it is expected to do; but warning should be given that it may take a liking to sugar-cane, and even to the potato and sweet potato.

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May 14.

Record of an African Fodder Grass from Central Burma

A NUMBER of exotic plants occur in the dry zone of central Burma. The annual rainfall of this area is only 25–35 in. in one monsoon, and the general vegetation is predominantly xerophytic—such as thorny shrubs, succulent species of *Euphorbia* and ephemerals. Some of these foreign plants are so well established that they could easily be mistaken for indigenous plants.

One of the common grasses of this dry zone is a scandent drought-resistant fodder grass, usually found trailing over thorny shrubs and common in hedgerows. This grass was sent to Kew in 1942, and has been identified by Mr. C. E. Hubbard as *Urochloa mosambicensis* (Hackel) Dandy[1]—a native of Central and East Africa. Other synonyms by which this grass is known are *Panicum mosambicense* Hackel[2], *Panicum notabile* Hook.f.[3] and *Echinochloa notabile* (Hook.f.) Rhind[4]. Both Hook.f. and Rhind expressed their doubts as to its affinities under the genera *Panicum* and *Echinochloa*, and Rhind contrasted its xerophytic characters with other species of *Echinochloa* of Burma.

On account of its value and possibilities as a fodder, this grass has attracted attention in Africa and Burma independently. It has been also introduced in Australia (Queensland), where it is said to be thriving well. It must have reached Burma very early, as Wallich collected it near the oilfields around Yenangyang in 1826 (Wall. Cat. 8723). Intentional introduction before Wallich's time is extremely unlikely, as traffic between the coasts of East Africa and Burma in those days was always scanty. Nevertheless, this appears to be the only possible route, as the plant is not recorded so far either from India or Malaysia. It is also not known how the plant reached Central Burma from the port (Rangoon), traversing the belt of heavy rainfall and swampy areas quite unsuitable for its growth. Most probably this took place accidentally, and the seeds must have been carried by river boats up the Irrawadi to the dry areas of central Burma, where the plant established itself.

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Rangoon, Burma.
June 12.

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[1] *J. Bot.*, 69, 54 (1931).

[2] *Bolet. Soc. Broter*, 6, 140 (1888).

[3] *Fl. Br. Ind.*, 7, 32 (1897).

[4] "The Grasses of Burma", 50 (1945).

Errors of Estimation in Inverse Sampling

IF a random sample of N individuals is taken from a population in which a proportion $P(= 1 - Q)$ possess a certain attribute, and of these N are found to possess the attribute, then, as is well known,

$$p = a/N$$

is an efficient and unbiased estimate of P. The variance of p is PQ/N; but unless N is large neither this quantity nor an estimate of it can be used directly in order to assign fiducial limits to p. If a probability level, say 0·05, is selected, upper and lower fiducial limits, p_U and p_L, may be defined; these are such that if P were equal to p_U, the probability of obtaining a or less individuals with the attribute in a sample of N would be 0·025, and if P were equal to p_L, the probability of obtaining a or more in a sample of N would be 0·025. Evaluation of p_U and p_L by successive approximation and summation of terms of a binomial expansion is tedious, but a table by W. L. Stevens[1] enables these 'true' limits to be obtained rapidly with sufficient accuracy for most practical purposes.

An alternative method of estimating P, that of *inverse sampling*, has been suggested as possessing advantages in some circumstances. This consists in taking individuals at random until a specified quota, A, possessing the attribute has been obtained. If this requires a total sample of n, the estimate of P is

$$p = (A - 1)/(n - 1);$$

the variance of p is approximately

$$s_p{}^2 = p^2q/(A - 2),$$

but s_p cannot be used for assigning fiducial limits to p except in large samples.

It may not have been generally realized that methods and tables for determining true fiducial limits for direct sampling may be adapted very easily to inverse sampling. For if p_U is the upper limit to a value of p estimated from inverse sampling, by definition it is the value of P for which the probability of obtaining the quota, A, in n or more trials is 0·025; this is the same as the value of p which, in direct sampling, would give $(A - 1)$ or less with the attribute in a sample of predetermined size $(n - 1)$. So p_L, the lower limit, is the value of P which would give the quota in n trials or less with a probability of 0·025, and is therefore the same as the value of p which, in direct sampling, would give A or more with the attribute in a sample of n. Hence the rule may be stated: in inverse sampling, the upper fiducial limit is the same as the upper limit for a direct sample with $N = (n - 1)$, $a = (A - 1)$, and the lower fiducial limit is the same as the lower limit for a direct sample with $N = n$, $a = A$. Stevens' table, entered according to his rules with the appropriate values of N, a, will then give the fiducial limits.

Haldane[2,3] has pointed out that, when p is small, its standard error in inverse sampling is practically a constant proportion of p for any fixed value of

Hence, by choice of a suitable value of A, the proportional standard error may be selected in advance of the sampling, a requirement which cannot be satisfied in direct sampling. Stevens' table records the limiting values of Np. For a fixed a and a fixed probability level, these are nearly independent of p, particularly for p less than 0·2; consequently, if P is known to be small, for any specified A, inverse sampling will give a value to $(p_U - p_L)/p$ almost independent of p. Hence, by suitable choice of A, the magnitude of the fiducial range relative to the estimate p may be determined approximately in advance of the sampling.

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May 9.

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[1] Table VIII 1 in Fisher, R. A., and Yates, F., "Statistical Tables for Biological, Agricultural and Medical Research" (2nd edition, 1943).

[2] Haldane, J. B. S., *Nature*, 155, 49 (1945).

[3] Haldane, J. B. S., *Biometrika*, 33, 222 (1945).

Application of the Method of Steepest Descents to X-Ray Structure Analysis

ALTHOUGH the Fourier method of synthesis has enjoyed a long and justified supremacy in the armoury of techniques for X-ray structure analysis, the time is rapidly approaching when its use will be limited by the complexity of the structures investigated. In the absence of any universally applicable method of obtaining phase angles, Fourier refinement can be applied only to those structures which are sufficiently simple for an accurate estimate of their parameters to be made. It is an unfortunate fact that the Fourier refinement process converges only if the trial parameters are reasonably close to the true ones, and the region of convergence is roughly that of the differential method[1].

Even when the general shape and disposition of the atoms in a molecule are known, it is often extremely difficult, using only trial and error or Patterson–Harker methods, to find the proper location of that molecule in the unit cell, and it is evident that a first step towards a unified treatment of structure analysis would be a means of treating such groupings as a whole. The methods of molecular transforms[2] cannot be regarded as a satisfactory solution to this problem since, as soon as the space-group symmetry becomes at all complicated, they become difficult or impossible to apply.

A third feature which would be desirable is some means of refining density distributions. This is particularly the case with biomolecular substances since, although in general it is impossible to make even a conjecture as to their detailed structure, it may be possible to form a reasonable estimate of their general shape[3].

The purpose of this note is to explain briefly the application of the method of steepest descents to the above problems. The detailed techniques have been worked out and will appear in full elsewhere, but sufficient detail will be given here to allow of the application of the method in its simplest form.

Suppose that a set of observed structure factors $F_0(h,k,l)$ is given, then a set of atomic co-ordinates is called a correct structure if:

(1) $R=\Sigma \,\|\, F_0 \,|-|\, F_c \,\|$ or $R_2 = \Sigma\ (F_0^2 - F_c^2)^2$ is a minimum.

(2) The structure is not impossible on stereochemical grounds.

It is possible that a structure, correct from this point of view, may not be unique. If this is the case, however, there is no means of telling which of several structures, having the same minimum value of R or R_2, is the real one. So that the point is one of philosophical interest only.

Suppose that a set of trial parameters x_{rj} ($r = 1,2, - N$; $j = 1,2,3$) is given, the problem is to vary them so as to minimize R_2 in the most rapid manner. Now the equation R_2 = const. represents some surface in the $3N$ dimensional space defined by the x_{rj}. The method of steepest descents simply specifies a procedure for moving from this surface to another having a smaller value of R_2. Starting from the point x_{rj} on $R_2 = C_1$, move in the direction of the normal to this surface until R_2 stops decreasing. Having arrived at this point on some surface $R_2 = C_2$, repeat the procedure. Evidently (neglecting cols and other singularities discussed elsewhere) the process converges to a minimum value of R_2, and the co-ordinates of this minimum are the required atomic parameters.

The analytical expression for the change ε_{rj} in any co-ordinate x_{rj} is simply:

$$\varepsilon_{rj} = -[\sum_{rj}\ (\partial R_2/\partial x_{rj})^2] \, . \, (\partial R_2/\partial x_{rj}) / \sum_{rj,r'j'} (\partial^2 R_2/\partial x_{rj}\partial x_{r'j'}) \, . \, (\partial R_2/\partial x_{rj}) \, . \, (\partial R_2/\partial x_{r'j'}), \qquad (1)$$

the derivatives being easily determined from the expression for R_2 and the algebraic form of $F(h,k,l)$.

In the early stages of a refinement it is usually easier to use the expression:

$$\varepsilon_{rj} = -\,2R_2 \, . \, (\partial R_2/\partial x_{rj}) / \sum_{rj} (\partial R_2/\partial x_{rj})^2; \qquad (2)$$

this requires care, however, as it leads to incorrect results when the x_{rj} are near their optimum values. As a practical rule, (2) should be used until a point is reached at which R_2 increases.

Similar expressions apply to R; but in this case particular care has to be exercised owing to the discontinuous nature of the moduli.

Despite the unpleasant appearance of (1) and (2), the calculations are quite easy, and much shorter than those of the Fourier method. As an example, the method was applied to the oxalic acid data and, starting from a *random* set of z parameters, the correct values were derived in three refinements which took only two and a half hours.

Application to the case of a known molecular shape is also easy; here the co-ordinates in some fixed set of axes are evaluated, and the whole frame of reference is rotated and translated until R or R_2 is minimized. The variables in this case are (x_0,y_0,z_0)—the co-ordinates of the origin, and (η,λ,μ)—the angles of rotation. Other applications cover the case where the molecule consists of a number of known groups, each of which can be treated as rigid.

Another modification of the method enables the molecule to be defined as a series of densities at lattice points; these densities are then varied to give a minimum value of R or R_2.

It is interesting to note that the method of least squares is a special case of the steepest descent technique, and is derivable from the same basic analysis.

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[1] Booth, A. D., *Trans. Farad. Soc.*, 42, 617 (1946).

[2] Wrinch, D., "Fourier Transforms and Structure Factors" (A.S.X.R.E.D., 1946).

[3] Perutz, M., *Nature*, 149, 491 (1942).

Effect of Bending on Selenium Rectifier Disks

BENDING a selenium rectifier disk causes a temporary increase of the current flowing through it in both directions. The effect (discovered in December 1942) is especially pronounced in the reverse direction, where a momentary increase of the current intensity up to 300 per cent and more can be produced through bending by hand, while in the forward direction values exceeding 5–10 per cent have not been observed. With copper oxide rectifiers no trace of a similar effect could be detected. The following, mostly qualitative, observations were made on our own disks, in the reverse direction: (1) The bending causes an increase of the current, whether the selenium layer lies on the convex or on the concave side of the disk. (2) In general, the stronger the bending the greater the effect. (3) The increase of current is, at its maximum, a temporary one. After bending a disk with a constant force, the momentary increased current intensity diminishes in the first few seconds rapidly, then slowly, and reaches its end value after some minutes. The behaviour of the disk is then, within certain narrow limits, that of a biased system: an increase of the bending increases also the current and *vice versa*. (4) Temperature has a pronounced influence; at 40–50° C., the effect is essentially smaller, and it seems to disappear more rapidly than at room temperature. (5) The effect depends upon the applied voltage. While at small voltages (1–2 volts) no effect is observable, with increasing voltages it increases also rapidly and reaches a maximal value as high as 350 per cent at 15–20 volts with some disks.

Selenium is a typical semi-conductor, its conductivity being due to the faults of the crystalline structure and to the impurities contained in it. Some of these centres are dissociated (into electron holes and negative ions) already in the mechanically finished disks, before forming, and determine the electrical properties of the disk at room temperature and below 1–2 volts. Further ionization—or expressed with modern terminology, transition of electrons to a conductivity-level—can be effected: (*a*) with thermal, (*b*) with electrical, and (*c*) with electrical plus mechanical energy. Thermal ionization goes on with any increase of temperature in the whole selenium layer and causes the temperature coefficient of the conductivity in the forward direction to be positive. Processes (*b*) and (*c*), however, take place only in the blocking layer, where an electrical field strong enough can be produced, thus explaining (*b*) the decrease of reverse resistance with increasing voltages and the phenomenon of 'electrical forming', with respect to (*c*) the bending effect.

In brief, we ascribe the bending effect to the dissociation of the impurity centres under the simultaneous action of electrical field intensity and the shearing stresses, impressed on the selenium layer by the bending. This assumption, together with the phenomenon of plastic relaxation, explains all the observations enumerated above.

Those interested in the new effect are invited to write for free samples of rectifier disks to the address below.

P. SELÉNYI
NICHOLAS SZÉKELY

Rectifier Laboratory, Electrical Undertaking,
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May 30.

Transformation of Trichromatic Distribution Curves

The purpose of this communication is to bring to attention a point which does not seem to be generally realized although it is quite simple to prove. If one of a set of three colour-matching stimuli is altered, *the distribution curve for that stimulus is not changed,* though one or both of the other two distribution curves is altered.

Consider a colorimeter in which white is matched by a mixture of one trichromatic unit each of three stimuli X, Y and Z. If some of the stimulus X is transferred from its own beam to the Y beam, we shall have a new primary G; but since the match with white is unaffected, one trichromatic unit each will be present in the new system of X, G and Z. Since one unit of G contains one unit of Y, and also some X, it follows that in matching any colour with a mixture of X, G and Z the same number of units of G will be required as of Y in a mixture of X, Y and Z. The amounts of Z required in the two systems will be the same, though the amounts of X will be different. Therefore, the spectral distribution curve of X will be altered but that of G will remain the same as that of Y.

Let $\bar{x}$, $\bar{y}$ and $\bar{z}$ be the spectral distribution coefficients of stimuli X, Y and Z, and $\bar{r}$, $\bar{g}$ and $\bar{b}$ those of a new set of stimuli, R, G and B, the trichromatic coefficients of which in the X, Y, Z system are u_1,v_1,w_1; u_2,v_2,w_2; u_3,v_3,w_3; where $u + v + w = 1$. Then where

$$\frac{\bar{x}}{\bar{x}+\bar{y}+\bar{z}} = u_1, \quad \frac{\bar{y}}{\bar{x}+\bar{y}+\bar{z}} = v_1 \text{ and } \frac{\bar{z}}{\bar{x}+\bar{y}+\bar{z}} = w_1,$$

the following relations must hold:

$$\frac{\bar{r}}{\bar{r}+\bar{g}+\bar{b}} = 1, \quad \frac{\bar{g}}{\bar{r}+\bar{g}+\bar{b}} = 0, \quad \frac{\bar{b}}{\bar{r}+\bar{g}+\bar{b}} = 0,$$

so that $\bar{g}$ and $\bar{b}$ must both be zero.

Similarly, if $\dfrac{\bar{x}}{u_2} = \dfrac{\bar{y}}{v_2} = \dfrac{\bar{z}}{w_2} = \bar{x} + \bar{y} + \bar{z}$, $\bar{r}$ and $\bar{b}$ must both be zero, etc.

If the same white-point is adopted in the two systems, then $\bar{r} = \bar{g} = \bar{b}$ when $\bar{x} = \bar{y} = \bar{z}$; hence we can derive the transformation equations:

$$\bar{r} = \frac{\begin{vmatrix} \bar{x} & \bar{y} & \bar{z} \\ u_2 & v_2 & w_2 \\ u_3 & v_3 & w_3 \end{vmatrix}}{\begin{vmatrix} 1 & 1 & 1 \\ u_2 & v_2 & w_2 \\ u_3 & v_3 & w_3 \end{vmatrix}}; \quad \bar{g} = \frac{\begin{vmatrix} u_1 & v_1 & w_1 \\ \bar{x} & \bar{y} & \bar{z} \\ u_3 & v_3 & w_3 \end{vmatrix}}{\begin{vmatrix} u_1 & v_1 & w_1 \\ 1 & 1 & 1 \\ u_3 & v_3 & w_3 \end{vmatrix}}; \quad \bar{b} = \frac{\begin{vmatrix} u_1 & v_1 & w_1 \\ u_2 & v_2 & w_2 \\ \bar{x} & \bar{y} & \bar{z} \end{vmatrix}}{\begin{vmatrix} u_1 & v_1 & w_1 \\ u_2 & v_2 & w_2 \\ 1 & 1 & 1 \end{vmatrix}}.$$

It will be seen that $\bar{r}$ is independent of u_1, v_1 and w_1; that is, of the position of R. If only one, say G of R, G and B, is different from X, Y and Z we have $u_1 = w_3 = 1$, $v_1 = w_1 = u_3 = v_3 = 0$, and the equations reduce to:

$$\bar{r} = \frac{v_2\bar{x} - u_2\bar{y}}{v_2 - u_2}; \quad \bar{g} = \bar{y}; \text{ and } \bar{b} = \frac{v_2\bar{z} - w_2\bar{y}}{v_2 - w_2}.$$

Moreover, if G is somewhere on the line XY, so that $w_2 = 0$ and $u_2 = 1 - v_2$, we have:

$$\bar{r} = \frac{v_2\bar{x} - (1-v_2)\bar{y}}{2v_2 - 1}; \quad \bar{g} = \bar{y}; \text{ and } \bar{b} = \bar{z}.$$

In other words, altering the green primary alters only the red and blue distribution curves, and if the green is moved along the red-green line the red distribution curve alone is changed.

It is perhaps of interest to note further that if in the last equation $v_2 \rightarrow \infty$, then $\bar{r} \rightarrow \frac{\bar{x} + \bar{y}}{2}$.

I wish to thank Mr. E. W. H. Selwyn and Dr. W. D. Wright for helpful comments.

A. MARRIAGE

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May 12.

Combination Tones

FROM time to time attention has been given to the objective reality of so-called 'combination tones' produced when two simple tones are sounded together. We have recently had an opportunity of investigating this experimentally, using a wave analyser of the degenerative type, employing an electronic circuit described by one of us[1]. The analyser has a high selectivity corrresponding to a Q value of about 100.

An approximately sinusoidal voltage at a frequency of 1,025 c./s. was superimposed on another approximately sinusoidal voltage of frequency 735 c./s., the r.m.s. amplitudes being 200 mV. in each case. Search was made for the difference frequency (290 c./s.) and the summation frequency (1,760 c./s.), and these were found to be practically non-existent. The strength of the 290 c./s. component was about 1 mV., and the summation frequency was too weak to be measured, although its presence was detected.

The analyser was designed to handle a total of 500 mV. (with the particular attenuator setting used in the experiment) with minimum distortion. Nevertheless, some slight distortion is to be expected which would give a rectifying effect and would probably account for the traces of combination tones which were observed.

The two input signals were simply added linearly, and quite different results would be expected if the amplitude of one tone were modulated at the frequency of the other.

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[1] *Engineer*, June 7, 1946.

Sublimation in Outdoor Air

IN a previous communication[1], experiments were described on the sublimation of water vapour in a Wilson chamber. It was found that in clean air sublimation commences only at temperatures below $-41{\cdot}2° \pm 0{\cdot}05°$ C., whereas in outdoor air at Oxford this threshold temperature is 9° C. higher.

With the view of investigating conditions at cloud-level, the Air Ministry arranged for me to visit the Hochalpine Forschungsstation at Jungfraujoch, which is 11,680 ft. above sea-level.

During tests lasting three weeks (April 1947) the threshold temperature there was found to be $-41{\cdot}2° \pm 0{\cdot}05°$ C., with the exception of two days, on which it rose to $-38°$ C. The air at Jungfraujoch during these two days was exceptionally hazy. On April 13 (the first occasion) there was an anticyclonic inversion which had developed during the previous night. On the second occasion, April 27, there was an exceptionally strong wind with general instability of the air mass.

It thus appears that whatever sublimation nuclei are effective in the lower air are usually absent from air at the height of Jungfraujoch.

This work is published by permission of the Director of the Meteorological Office.

B. M. CWILONG

Clarendon Laboratory,
Oxford. June 4.

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[1] *Nature*, 155, 361 (1945).

Silicon Flame Bands

WE have recently made a preliminary study of the visible spectrum of flames of hydrogen charged with silicon tetrachloride burning in air. In a Méker burner with restricted supply of air, grey-blue cones are developed, and spectrograms of these taken on a low-dispersion prism instrument show a number of bands, apparently degraded to the violet, in the range 4200–5700 A. The strongest head is at about 5240 A., and a tentative vibrational analysis gives $\omega'' \sim 750$, $\omega' \sim 1050$ and $\nu_e \sim 19{,}000$ cm.$^{-1}$.

The circumstances in which these bands are produced suggest that the emitter may be Si_2, and the provisional values of the constants given above do not conflict with this view; but unambiguous identification must await the results of a detailed study with instruments of higher dispersion. This work is in progress.

A. R. DOWNIE
R. F. BARROW

Sir Leoline Jenkins' Laboratories,
Jesus College, Oxford.
May 20.

What is a Dialysate ?

THE "Oxford Dictionary" defines 'dialysate' as that portion of a mixture that remains after dialysis, and quotes Attfield's "Text-book of Chemistry" (1885). The quotation shows that the part that fails to pass through the membrane is referred to. From the point of view of the lexicographer, this is perfectly satisfactory; there seems to have been no earlier use of the word in print. Graham, for example, although he coined the word 'dialyser' and gave a new meaning to the word 'dialysis' did not apparently use 'dialysate'.

Present-day usage does not agree with the "Oxford Dictionary". Nearly all the biochemists that I have consulted have understood by dialysate the more diffusible part of the system. At present, therefore, the word is ambiguous unless the context makes the meaning clear. Many authors and editors have not read Attfield, and some of those who have may question his authority in the matter. The popular meaning has probably been adopted because of the analogy with filtrate, distillate, sublimate, etc.; in each case the more mobile part of the system is referred to. The continuing existence of this analogy will make it difficult to get universal acceptance of the dictionary meaning of dialysate.

We are left with no word except colloid for the part of a system that is retained by the dialysis membrane. This is unfortunate, but it is better than ambiguity.

N. W. PIRIE

Rothamsted Experimental Station,
Harpenden. June 12.

BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

OPENING OF NEW LABORATORIES

A NEW chapter in the history of the British Scientific Instrument Research Association commenced on July 10, when the new laboratories of the Association at "Sira", Southill, Elmstead Woods, Kent, were formally opened by the Minister of Supply, the Right Hon. John Wilmot. The Association, which was founded in 1918, has been for many years handicapped by its limited resources and facilities. At the time of the inauguration of the Association, it could not do more than adapt a house in Russell Square, London, to laboratory use, and the limited facilities which were established there compelled the Association to direct its activities into certain well-defined channels of restricted operation. These circumstances made it difficult to attempt to establish a membership representative of all scientific instrument interests, and in consequence the Association has in the past prosecuted researches which, although extremely valuable to the particular interests served, have not ranged over the total requirements of the industry. From the commencement of the rearmament programme, many firms not in membership with the Association extended the scope of their activities to an extent which brought them within the field of research covered by it, and in consequence the membership, which at that time included twenty-five instrument firms, rapidly increased to more than one hundred. At the conclusion of the War, the Council of the Association formulated a scheme of expansion to permit it to meet the research needs of the enlarged membership in an adequate manner. This scheme was approved by the Department of Scientific and Industrial Research, which offered very considerable practical support, and it has now come to fruition.

The enlarged Association consists of six Experimental Departments and an Information Department. The Association was fortunate in acquiring a mansion at Elmstead Woods, Kent, which, by reason of the number and size of its rooms, was admirably suited to the experimental purposes of a research association. The work of conversion has been completed, and the experimental activities of the Association have now been transferred to the new laboratories at Elmstead Woods, situated in five acres of grounds in very beautiful surroundings, where the conditions of working are almost ideal.

Optical Instrument Department. A predominant feature of the past activities of the British Scientific Instrument Research Association has been work on problems associated with optical instrument production. While the Optical Department now takes its place as one of several, the facilities for this branch of the work have, in fact, been increased. The space devoted to optical work at Russell Square is now occupied by the Computing Section of the Department; while in the new premises a general optical laboratory has been established, ample provision has been made for the work on graticules and allied problems, and room has been set aside for interferometers and other standard testing equipment. The work of the Department can now expand beyond that connected with the processes and the materials used in manufacture to the investigation of problems of the actual instruments and to the development of new types.

Chemistry Department. Chemical research plays no small part in the activities of the Association, and the importance of this branch of the work is reflected in the excellent chemical laboratories to be found at "Sira". The old ballroom has been converted into a spacious general laboratory which is very completely equipped. In addition, two smaller laboratories provide facilities for specialized researches. The making of experimental melts of technical glasses, which has always been a main feature of the work of the Association, will be continued in a new glass-founding shop set up in an outhouse formerly used as a domestic laundry.

Physics Department. Many of the investigations undertaken by the Association are best carried out in orthodox physical laboratories. Three of the new laboratories have been allocated to physics; one is a large general physical laboratory, another is devoted to work involving high vacua, while the third has been set aside for special independent research.

Electrical Instruments Department. The Association has for many years included among its membership some manufacturers of electrical instruments; but experimental work carried out on their behalf has been limited to such as could be covered by normal chemical and physical laboratory facilities. There is no more heartening aspect of the expansion of the Association than that it permits problems peculiarly associated with electrical instruments to be investigated with adequacy. New laboratories have been equipped bearing especially in mind the needs of the electrical instrument membership, and benefits should accrue to this class of member on a scale far larger than was possible in the old circumstances.

Electronics Department. Electronics have in recent years made a very considerable incursion into the field of instrument design. Laboratories have been established in the new premises, which are equipped in a manner most suitable to the carrying out of investigation of problems arising through the application of electronics to scientific instruments. Any work carried out in the past by the Association in this connexion has been prosecuted under conditions of improvisation. The new laboratories have been planned and equipped specifically to meet the requirements of this branch of the Association's work.

Mechanical Department. The investigation of mechanical problems has not in the past fallen within the purview of the Association, and in consequence there has existed a wide gap in the service it has been possible to render to the makers of mechanical instruments or, in respect of their mechanical problems, to instrument makers in general. It is therefore most appropriate that mechanical facilities have been provided under the new scheme. A mechanical laboratory equipped with modern machine tools has been established, drawing office facilities are now available, and a modern workshop is in process of completion.

Information Department. The first fruits of the scheme of expansion was the establishment of a comprehensive Information Department and Library, which remain at Russell Square. The work of abstraction from numerous technical journals, incorporated in the monthly *Bulletin*, the provision of information on a very wide range of subjects, the library facilities, with its lending arrangements, have already proved of great benefit to the membership and to the research staff of the Association.

Such is the present position of the Association, which is looking forward to achieving on behalf of the scientific instrument industry as a whole even more beneficial results than those which in the past have been enjoyed by a restricted section of the industry. Every branch of instrument making is now effectively represented in the membership of the Association, and the opportunity exists for the influence of the Association to spread in many new directions. In his speech at a luncheon which followed the opening ceremony, the Minister of Supply remarked, "The instrument makers look to the Association for help in solving their problems and overcoming their difficulties. From what I have learned of the Association, they will get this help. The member-firms of the Association are supplied with a monthly *Bulletin* dealing with the latest results in research and development, and there is, in addition, a fund of technical information available in the excellent Library maintained by the Association. The achievements of the Association are far too many to enumerate; but I was interested to learn that nearly two hundred research reports have been issued by the Association, and these, I know, are of great interest to the manufacturers. The British Scientific Instrument Research Association is the oldest surviving research association connected with the Department of Scientific and Industrial Research, having been formed in 1918, when it had no more than nine members; to-day the membership exceeds one hundred. The Association's record is such that with the greatly increased facilities at Elmstead Woods it will be surprising if the present membership is not increased in the near future. The Association has already contributed greatly to the tools and instruments which have established the good name of British workmanship in the past, and I am sure it will maintain and even improve this reputation. . . . I would like to express the gratitude of the Government in general and of my own Ministry in particular for the great achievements of the Association in the past."

POLLUTION BY TRADE WASTES FROM FOOD INDUSTRIES

THE cause and effects of pollution by waste waters from food industries, and the prevention of this pollution, were discussed by Dr. B. A. Southgate and Dr. S. H. Jenkins at a joint meeting of the Food Group of the Society of Chemical Industry and the Midland Section of the Society held at Birmingham on May 23; Mr. T. Rendle presided.

Some waste waters contain directly toxic substances such as cyanides, phenols, and metallic compounds; in wastes from the food industries, however, pollution is due mainly to organic matter in solution and in suspension. Organic matter discharged into a stream is oxidized by bacterial action at the expense of the oxygen dissolved in the water. The rate of oxidation increases with rise in temperature; consequently a rise in temperature causes a decrease in the concentration of oxygen dissolved in the water, because this is the result of an equilibrium between the rate at which it is used in processes of oxidation and the rate at which it is absorbed from the atmosphere. As an illustration, in the winter the polluted estuary of the River Tees may contain dissolved oxygen equivalent to 70–80 per cent of the amount required to saturate the water, whereas in summer the corresponding concentration may be as little as 0 to 10 per cent of the saturation value. If the content of dissolved oxygen falls below about 50 per cent of the saturation value, the water may be unsuitable for fish, though they can live at much lower concentrations, particularly at low temperatures, at least for comparatively short periods.

Other effects of discharge of waste waters from the food industries include the deposition of organic sludge which may undergo anaerobic fermentation in warm weather, and which may cause marked changes in the distribution of bottom-living invertebrates, many of which serve as food for fish. Discharge of organic matter may also lead to the growth of 'sewage fungus'; this term is applied to a wide variety of Bacteria, Fungi, and Protozoa or associations of them, usually whitish-grey in colour and resembling cotton wool in appearance. These growths are found adhering to vegetation and stones in many polluted streams, and usually cause silting on the river bed. When the fungus dies it is decomposed by bacterial action, with absorption of oxygen from the water and sometimes with evolution of hydrogen sulphide.

Waste waters from food industries may cause difficulty in the use of surface waters for domestic supply; the presence of organic matter may make the water unpalatable; ammonia may interfere with the treatment of water by chlorination; and nitrogenous compounds may stimulate growth of Algæ which cause difficulty in sand filters and may also give rise to unpleasant tastes.

When the construction of a food factory is being planned, the possibility of pollution resulting from trade effluents must be borne in mind. Pollution is sometimes avoidable by erecting factories where sewers and sewage disposal works are at hand to deal with any waste water. When vegetables or fruit must be conveyed to a factory in a fresh condition, this is not always possible, and treatment of the waste water at the factory then becomes necessary.

The volume of waste water produced and its impurity content varies greatly from factory to factory, depending upon the product made, the management, and the amount of water available for processing. The organic matter in the waste water can be expressed in terms of an equivalent amount of domestic sewage and therefore in terms of population. For example, a beet sugar factory handling 1,000 tons of beet daily may discharge up to four million gallons of waste water daily, containing organic matter equivalent, in some cases, to the sewage from about 2,000 persons and in other cases to the sewage from 20,000 persons. Food wastes show marked fluctuations in the polluting matter content because processing varies with the time of year: a tenfold increase in the polluting strength of the waste water within a matter of a few weeks is not at all uncommon. This variation in strength, and also the fact that the waste water is frequently produced over a short period of the day, introduces difficulties in designing treatment plants for purifying the factory wastes.

The methods used for purifying food wastes have developed from those employed for sewage treatment. Fibrous matter, rootlets, peelings, etc., are removed by passing the water through screens; suspended mineral matter is then separated and the organic matter in suspension removed by continuous passage through sedimentation tanks. The residual polluting matter in solution is eliminated by biological oxidation by: (1) allowing the liquid to percolate through suitable soil; (2) distributing it over a filter bed made of inert material resting on a well-drained floor, so as to cultivate on the inert material a flora and fauna able to oxidize the organic impurity in the waste water; or (3) aerating a mixture of the waste water and a heterogeneous culture, known as activated sludge, which consists of organisms grown from the waste water.

All pollution prevention authorities agree that industrial wastes are best treated at sewage purification works. The Public Health (Drainage of Trade Premises) Act, 1937, gives manufacturers the right to use public sewers and sewage works for disposing of trade wastes, provided they do not injure structural materials or inhibit purification. Some food wastes, especially those from the fermentation industries, may cause very serious interference with treatment of the sewage when present in high concentration, but ordinarily the difficulties encountered are surmountable.

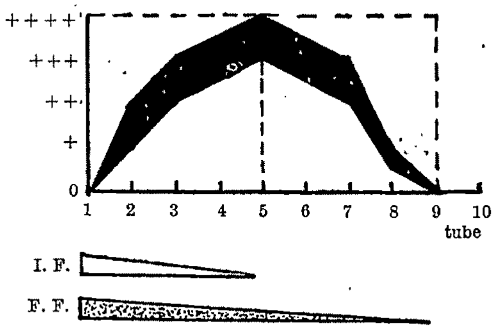
In discussion of the two papers, it was stated that the growths in a river receiving beet sugar waste had caused trouble on the screens at an electric power station ten miles below the factory. Wastes containing sugar favour such growths over a long stretch of river in cold weather: in warm weather, the sugar is rapidly oxidized and so the region of pollution is smaller, though the extent of pollution is greater. Decomposition of solid matter on the bed of a stream was also discussed. Anaerobic organisms break down such matter into gaseous products, or into substances which are then oxidized by aerobic organisms. The effects of Algæ were also mentioned. During the day, photosynthesis by Algæ raises the dissolved oxygen concentration in rivers, and when algal growth is marked, there is a diurnal variation in the dissolved oxygen content of the water. A prolific growth of Algæ might be followed by a lowering of the dissolved oxygen in the water when the Algæ die and decompose.

Further discussion was concerned with methods of analysis, means for assessing the amount of polluting matter in waste water, the treatment of wastes by means of chemical precipitants, the disposal of the sludge or solid matter in waste water, the dissolved oxygen content of sea water, and the difficulty of obtaining supplies of constructional materials for trade-waste purification plant.

A NON-SPECIFIC RESISTANCE FACTOR IN THE ALBUMIN RESIDUE REVEALED BY THE SERIAL CEPHALIN FLOCCULATION CURVE

By Dr. JACK G. MAKARI
Department of Bacteriology, American University of Beirut, Lebanon

IN the last laboratory meeting of the Royal Society of Tropical Medicine, I demonstrated the various types of serial cephalin flocculation curves as obtained in health and disease with a special reference to their application in tropical derangements. In obtaining the curves, the serial dilution method was followed[1], using ten tubes instead of Hanger's original one-tube method[2]. Serial cephalin flocculation curve I, shown in the accompanying figure, represents the normal range in fifty healthy volunteers. In a study of the mechanism of Hanger's test, which is comparable to the first tube in the serial dilution method, Kabat, Hanger *et al.*[3] found the flocculating factor to be associated with the γ globulin. They failed, however, to find an inhibiting fraction in the albumins. Moore, Pierson *et al.*[4], two years later, reported from the same laboratory the presence of an inhibiting fraction associated with the albumins. It is to be noted that these workers were using electrophoresis by means of which albumins appear homogeneous[5]. Dennis and Makari[6], using salting-out methods, found the greatest concentrations of this inhibiting factor in the albumin residue. Since this inhibiting factor was found by the latter workers to be originally present in the serum in smaller amounts than the flocculating factor, the critical dilution-level of 0·04 mgm. is reached much earlier in the case of the inhibiting factor. The first zone representing the first five tubes in the figure presents, therefore, a delicate balance between flocculating factor (γ globulin) and inhibiting factor (albumin residue). In the second zone only the former is at work. This delicate balance in this first zone represents as well a balance between the liver and reticulo-endothelial system.



Further study of this inhibiting factor present in the albumin residue of man and revealed by the first zone of the serial cephalin flocculation curve shows that it plays an important part in relation to drug administration, immunization, relapse and the outcome of infection in man.

The figures in the tables indicate the extent of deviation of this inhibiting factor from the normal range in health (serial cephalin flocculation curve I) recorded in ⅛ in. square units. A deviation below the normal curve, that is, an increase in inhibition, is designated as positive, while a deviation in the opposite direction is designated as negative. Reference to the dosage is made as follows: for quinine up to 3 gm. as small dose, 3–6 gm. as medium dose, and more than 6 gm. as large dose; for atebrin up to 0·6 gm. as small dose, between 0·6 and 1·2 gm. as medium dose, and larger amounts than 1·2 gm. as large dose.

Vaccination with T.A.B. was accomplished by the subcutaneous administration of 500 million bacteria; a double dose was given one week later and repeated one week later still. The typhoid cases studied were reported earlier in relation to Hanger's test[7].

No reference is made in this preliminary report to changes in the flocculating factor which reflect reticulo-endothelial stimulation. This latter aspect will be referred to in the detailed report.

It is apparent from Table 1 that both quinine and atebrin give rise in healthy volunteers to a positive inhibiting factor response; atebrin resulting in greater stimulation over a shorter period.

A transient positive inhibiting factor response is also observed as a very early manifestation of

TABLE 1

	Treatment given	Deviation of I.F. response from normal S.C.F. curve I				
		Before treatment	After small dose	After medium dose	After large dose	Residual effect (1 week later)
Normal volunteers						
(*a*) Group I (average in 6)	Quinine	0	0	+11	+11	0
(*b*) Group II (average in 5)	Atebrin	0	0	0	+15	−1
Malaria, *P. vivax*						
(*a*) Primo infection						
1. Yahya (2nd day)	Quinine	+14	0	−5	−10	+5
2. Mansour (6th day)	Quinine	−10	−5	−4	−21	
	Atebrin			−10	+23	
3 Omaima (10th day)	Quinine	−5	−3	0		
(*b*) Relapsing malaria						
4 Mary (8th month)	Atebrin	−10	+5	−15	+9	0
5 Souad (18th month)	Atebrin	−18	−13	+14	+16	+32
Malaria, *P. falciparum*						
(*a*) With cerebral symptoms						
6 Hassib (4th week)	Atebrin	−24		−24	−24	
7 Samaha (4th week)	Atebrin	−24			−10	
(*b*) Without cerebral symptoms						
8 Paul (2nd week)	Atebrin	−4		−4	0	
9 Mohamed (2nd week)	Atebrin	−6	−2		−5	0
10 Farhan (4th week)	Atebrin	−4			−1	
(*c*) With blackwater fever						
11 Atassi	Atebrin	−21	−5		+16	0

TABLE 2

	Deviation of I.F. response from normal S.C.F. curve I										
	Before	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	8th month	12th month
Normal volunteers (average of 50) Effect of vaccination with T.A.B.	0	+9	+5						+1	0	0
Typhoid cases—uninoculated											
(*a*) Severe infection		−1	−4	−10	−10	−4	−1	−1	0		
(*b*) Moderately severe case with relapse		−4	+5	−10	−10	−4	0				
Typhoid cases—inoculated		−1	+10	+32							

malarial infection (Case 1). This soon gives way to a negative response, which was more marked in Case 2 observed on the sixth day of illness and less so in Case 3 observed on the tenth day of illness. More marked initial inhibiting factor depletion was obtained in the two cases of relapsing malaria and most marked in *P. falciparum* infections with cerebral manifestations (Cases 6 and 7), and with blackwater fever (Case 11).

The course of the struggle between the malarial parasite and the host as well as the aid provided by quinine and atebrin seem to be mirrored by fluctuations in this inhibiting factor response. Thus a renewal of clinical activity in Case 2 was ushered in by a maximal negative inhibiting factor depletion, while a positive inhibiting factor response was associated with a remission. A similar finding was observed in a typhoid relapse (Table 2).

Furthermore, the extent of these fluctuations and the degree of residual stimulation seems to be of significance in determining the outcome of this struggle. Thus in two cases of relapsing malaria, Case 4 showed more fluctuations but no residual inhibiting factor stimulation, while Case 5 showed a steady increase in inhibiting factor with a maximal residual inhibiting factor response. The former patient continued relapsing for another eight months, while the latter showed no more relapses over a two-year period of follow up. In the two cases of *P. falciparum* infections with cerebral manifestations, it was found that Case 6 showed a complete absence of any inhibiting factor response despite 2 gm. of atebrin, while Case 7 showed a sluggish response. The former died while in the hospital, and the latter left the hospital as improved.

Of interest is the very sluggish inhibiting factor response obtained despite atebrin therapy in all *P. falciparum* infections. The only exception encountered was the case of blackwater fever, which showed a surprisingly good inhibiting factor response, even to the small dose of atebrin given.

Table 2 shows the positive inhibiting factor response obtained in fifty healthy volunteers as a result of immunization with T.A.B. vaccine. It also shows the negative inhibiting factor response which results from infection with *E. typhi*. In a severe case observed in a non-inoculated patient this negative inhibiting factor response appeared in the first week, reached maximal depletion in the third week and remained until the eighth week. In contrast to that the phase of negative inhibiting factor response was much shorter in the inoculated group, being over by the second week. This was in agreement with the clinical severity observed in the uninoculated as compared to the inoculated groups.

There is therefore evidence to indicate that this inhibiting factor present in the albumin residue of man, which is detectable in the serial cephalin flocculation curve and which is possibly elaborated by the liver, is in fact a *resistance factor*—of great importance in determining the course and outcome of this struggle between host and parasite. A decrease of this resistance factor shifts the balance in favour of the parasite, while an increase shifts the balance in favour of the host.

Such an increase in the resistance factor could be brought about by two different mechanisms :

(1) An immediate and non-specific increase as a result of the administration of *non-antigenic* substances as in the case of the two drugs used, quinine

and atebrin. This effect is maximal during the administration of the drug, when large doses are reached. There seems to be no residual and no delayed effects.

(2) A residual and a delayed increase brought about by the repeated administration of *antigenic* substances as in the case of T.A.B. vaccine or as occurs with repeated attacks of malaria and the resultant liberation of malarial proteins. This second mechanism seems to be more specific, but is distinct from the specific globulin antibody response which is also obtained in these cases. The residual effect obtained in the case of this resistance factor was maximal one week after the cessation of immunization, whereas the antibody response demonstrated by the zone of flocculation in the serial cephalin flocculation curve was maximal two weeks after the cessation of immunization.

The delayed effect comes into action whenever the immunized host is infected with the same agent.

A more detailed account is in the press.

I wish to thank Prof. E. W. Dennis, head of the Department of Bacteriology and Parasitology of the American University of Beirut, for his valuable advice.

[1] Makari, J. G., *J. Trop. Med. and Hyg.*, **49**, 113 (1946).

[2] Hanger, F. M., *Trans. Assoc. Amer. Phys.*, **53**, 148 (1938).

[3] Kabat, E. A., Hanger, F. M., Moore, D. H., and Landow, H., *J. Clin. Invest.*, **22**, 563 (1943).

[4] Moore, D. B., Pierson, P. S., Hanger, F. M., and Moore, D. H., *J. Clin. Invest.*, **24**, 292 (1945).

[5] Cohn, E. J., Oneley, J. L., Strong, L. E., Armstrong, S. H., and Hughes, W. L., Jr., *J. Clin. Invest.*, **23**, 417 (1944).

[6] Dennis, E. W., and Makari, J. G., in the press.

[7] Makari, J. G., *J. Trop. Med. and Hyg.* **49**, 70 (1946).

INTERSTELLAR MATTER

THE George Darwin Lecture entitled "Some Phenomena connected with Interstellar Matter" was delivered by Prof. J. H. Oort before the Royal Astronomical Society on May 10, 1946, and the lecture has now been published in full (*Mon. Not. Roy. Astro. Soc.*, 106, 3; 1946). Prof. Oort deals more with a survey of the problems presented by interstellar matter than with an account of our present knowledge on the subject. The uneven distribution of interstellar matter is the first characteristic that strikes the investigator, and this applies to interstellar gas as well as to obscuring clouds. On the average, the light from a star 1,000 parsecs distant traverses five clouds, and it can now be accepted that the dark clouds contain proportionate concentration of gas. It has been shown that, on the average, the intensities of interstellar lines increase proportionally with the distances of the stars in all galactic longitudes, the only explanation of which is that these lines are mainly formed in clouds having 'peculiar' velocities averaging 15 to 20 km./sec. in the radial component.

The very uneven distribution of obscuring matter is noticeable even in the galactic plane, and two extended systems of dark clouds are found in our neighbourhood, one in the Taurus–Auriga–Perseus region, and the other in Ophiuchus and Scorpius. Both systems cover regions of about 500 square degrees and show an average absorption of mag. 0·8, although they are comparatively close to us—about 100–150 parsecs. In contrast to the strong absorption in these clouds, there are very faint Cepheids in Cygnus the apparent magnitudes of which are scarcely affected by absorption, although their distances are between 10,000 and 20,000 parsecs. As the average diameters of the interstellar clouds are of the order 100 parsecs and their peculiar velocities 20 km./sec., a cloud will encounter another in about 10^7 years, and some remarkable effects will result from such an encounter. Incidentally, it might be expected that the individual cloud systems and their relative motions would disappear in a time short in comparison with the age of the galactic system; but as this has not occurred there must be some mechanism causing reformation and motion. Independent data suggest that this is taking place, and the six-colour photometry carried out by Stebbins and Whitford, as well as other evidence, show that the dependence of interstellar scattering upon wave-length is the same for all stars, no variation occurring whether observations are made through dense clouds or through a thin medium. This implies that particles within dense clouds have the same radii as outside particles; and if it is assumed that these particles grow by condensation from the interstellar gas, the only interpretation is that the clouds are being continually reshuffled.

Two effects will result from an encounter between clouds. First of all, the intermediate region between the clouds will be compressed, and if the relative velocity of an encounter is 30 km./sec., the density and temperature in this region will be three times their value in the clouds. Hydrogen will be ionized by collisions and the gas will become luminous, the luminosity being most conspicuous when the interface between the clouds is in the line of sight from the earth. This may be the explanation of the bright rings often observed near the dark nebulæ when these are bordered by luminous nebulæ, and the luminescence of nebulæ like the extensive nebulosities near Zeta Orionis or the North American nebula may be caused by this collisional mechanism rather than by radiation from the stars.

Another effect is the evaporation of the solid particles of the two colliding clouds when the particles of one cloud hit other particles of comparable size. The probability of such evaporation cannot be ignored, and it may play an important part in the realm of interstellar material. This leads to the problem of the origin and growth of these solid interstellar particles, of which the radii are 1,000 A. A full discussion of this last and very important question would be impossible in the limited space, but briefly it can be said that an order of magnitude of 10^{-24} gm./c.c. for the density should preserve a balance between condensation and evaporation.

Among other astronomical problems in which interstellar material plays an important part reference may be made to the significance of interstellar material in the extragalactic nebulæ. There is no trace of it in the elliptic nebulæ; but it is very prominent in the spiral nebulæ, especially in the case of objects seen on edge. If the dark matter were comparable in mass with all the stars in a nebula, it might lead to instability, and spiral arms would be formed. The absence of such material in the elliptic nebulæ would offer a possible explanation of their stability; but it is admitted that such suggestions are still merely speculative.

The problem of the resistance of interstellar gas to the expanding shell thrown off by a nova is considered, and it is shown that in the case of an ordinary nova expanding in an interstellar medium of average density the deceleration should be observable within half a century. For supernovæ the deceleration would become visible only after several thousand years.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Assistant to teach Civil Engineering subjects, particularly Surveying and Structures to honours degree standard, Assistant Lecturers to teach in some selected branch of Civil or Mechanical Engineering up to degree standard, Assistant Lecturers to teach classes of a Workshop or Production Engineering character up to Higher National Certificate in Production Engineering and/or Motor Vehicle Service work for the National Craftsman's Certificate, and a Lecturer in Mathematics—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (August 16).

Lecturer in Metallurgy with Special Responsibility—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (August 16).

Lecturer (Grade I) in Organic Chemistry, a Lecturer (Grade IIa) in Chemistry, and Lecturers (2, one Grade I, one Grade IIc), mainly for research into the chemistry of high polymers and elastomers—The Secretary, The University, Edmund Street, Birmingham 3 (August 18).

Biochemist for research in endocrinological unit—Prof. Zuckerman, Anatomy Department, Medical School, Hospitals Centre, Birmingham 15 (August 18).

Physicist for research on applications of physics to medical problems, and an Assistant Physicist—The Secretary, Barnato Joel Laboratories, Middlesex Hospital, London, W.1 (August 23).

Zoologist for work in collaboration with the Water Pollution Research Laboratory at Watford on ecological and physiological problems connected with polluted waters—The Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland (August 23).

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Senior Lecturer in Botany in the Rhodes University College, Grahamstown—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W.C.2 (August 31).

Lecturer in Biochemistry—The Professor of Chemical Pathology, British Postgraduate Medical School, Ducane Road, London, W.12 (September 1).

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Readership in Economics (Banking and Currency) tenable at the London School of Economics—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 4).

Senior Experimental Officer or Experimental Officer (temporary), Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting A.261/47A (September 5).

Principal Scientific Officer or Senior Scientific Officer (temporary), Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting A.260/47A (September 5).

Senior Scientific Officer or Scientific Officer (temporary), Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting A.259/47A (September 5).

Principal Scientific Officer (temporary), Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting A.258/47A (September 5).

Deputy to the City Analyst—The Medical Officer of Health, Public Health Department, Leeds, endorsed 'Deputy City Analyst' (September 8).

Engineer Control Officers (temporary), Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting C.417/47A (September 13).

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Professor of Chemistry in University College, Dundee—The Secretary, The University, St. Andrews (September 15).

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Lecturer in Physics—The Registrar, The University, Reading.

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Forester as Head of a Forestry Division for the Directorate General of Agriculture, Government of Iraq, The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18183.

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Assistant Lecturer in Physics—The Registrar, University College, Exeter.

Senior Lecturer or Lecturer in Philosophical Psychology, and an Assistant Lecturer in Experimental Psychology, in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

Hydrographical Surveyor (Grade III) by the Government of Iraq for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.17048.

Curatorship of the Zanzibar Peace Memorial Museum—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Lecturer in Electrical Engineering, Technical Institute, Lagos, Nigeria—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Hood Professor of Mining—The Secretary, The University, Edinburgh.

Director of Museums, Museums Department, Malaya, and a Curator of the Perak Museum, at Taiping—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

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REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 589, Vol. 232: Experimental Investigations of the Shoot Apex of *Dryopteris aristata* Druce. By C. W. Wardlaw. Pp. 343–384 + plates 10–14. (London: Cambridge University Press, 1947.) [63

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SOCIOLOGICAL SIGNIFICANCE OF LANGUAGE AND CULTURE

IT became very evident during the Second World War that England was unable to produce, at a time when their services were most urgently needed, sufficient experts in Slavonic, East European, Near Eastern, Far Eastern, and African languages to carry out essential military and political functions. Still fewer men could be found who combined a knowledge of these languages with an equal knowledge of the peoples who speak them and of their histories, social structures, and cultures. It has also become clear that, as a result of the War, British relations with these peoples will have to be based far more than hitherto on personal contacts, demanding sympathetic understanding of their ways of life and thought, and that an aloofness born of political and economic supremacy can no longer be afforded.

The realization that the study of Oriental, African, Slavonic, and East European languages, societies, and cultures is of national importance and, therefore, a concern of the State led to the appointment by Mr. Eden of an interdepartmental commission of inquiry, presided over by the Earl of Scarbrough, in December 1944. Its terms of reference were : "To examine the facilities offered by universities and other educational institutions in Great Britain for the study of Oriental, Slavonic, East European and African languages and culture, to consider what advantage is being taken of these facilities and to formulate recommendations for their improvement".

The Commission concludes from its inquiry* that the present provision for these studies is "unworthy of our country and people". Even this is an understatement. The state of linguistic and sociological research in the whole area within the Commission's terms of reference is deplorable. The facilities for teaching the required subjects in Britain were in 1939 well behind those in several European countries.

The chief reason for the public indifference which the Commission deplores is, as its report stresses, the absence of a sound academic tradition in the subjects under consideration. There have been here and there isolated professorships ; but there have lacked strong teaching departments in which a tradition could grow and be added to by one generation of scholars after another. It was not until 1916 that, to implement the findings of Lord Reay's Committee, the School of Oriental Studies was established in London, largely through the energetic backing of Lord Cromer and Lord Curzon. It took the stimulus of the First World War to bring about the establishment in 1918 of the School of Slavonic Studies, also in London. Credit for the foundation of the International African Institute in 1926, under the chairmanship of Lord Lugard, must be given to private initiative and American generosity.

The report of the Scarbrough Commission, therefore, lays it down that there can be no public enlightenment about the Far and Near East, Eastern

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* Foreign Office. Report of the Interdepartmental Commission of Enquiry on Oriental, Slavonic, East European and African Studies. Pp. 192. (London : H.M. Stationery Office, 1947.) 3s. net.

Europe, and Africa until an academic tradition has been created in university departments dealing with the languages and cultures of these areas. It goes on to point out that no such tradition can be created, especially to-day when there is no longer a leisured class in Great Britain, and the Diplomatic, Consular, and Colonial Services are no longer leisurely occupations, unless students can be assured professional status and financial security. For a man without private means to take up as his life's work a study regarded by most people, including his relatives and friends, as a hobby of well-to-do eccentrics, he must have adequate funds to maintain himself during his training and research and until he has had time to publish enough of the results of his research to qualify for a teaching post. He must also have reason to believe that if he does qualify for a teaching post by the excellence of his work, there is a possibility of there being a place for him in some university department; for the genuine scholar is seldom willing to be absorbed into some other occupation for which his specialized knowledge may seem to qualify him. Neither of these pre-requisites to an academic career in the subjects under discussion have existed in the past. If the Commission's recommendations are accepted by the Government, however, they will exist in the future.

The report, which is comprehensive and admirably to the point, asks first for the strengthening of university teaching departments and the creation in certain cases of new departments in universities other than Oxford, Cambridge, and London; secondly, for a generous allotment of post-graduate studentships; and thirdly, for the establishment of research centres abroad in close liaison with British universities. These are minimum requirements involving very moderate expenditure spread over a number of years. In return for its aid, the State will receive training facilities for careers in the various countries covered by the report, and, eventually, a better informed public opinion about these areas, which are inhabited by nearly five-sevenths of the population of the world.

If the State is to receive this return, the universities must ensure, says the report with very good sense, that there is a fair balance between classical and modern studies and between linguistic and cultural studies. The tendency in the past, perhaps particularly in Semitic studies, has been to concentrate far too much on the classical literature to the neglect of the language spoken and written to-day. There has also been undue emphasis on purely linguistic teaching. A language can, of course, be learnt without the learner knowing much about the history, culture, or social life of the people who speak it; but it certainly cannot be understood without a sound knowledge of them, and there is no more fallacious guide than the man who speaks a people's language but has not studied their institutions and values. The absence of sociological research in the Near and Far East is astounding. It would not be going too far to say, for example, that no comprehensive and intensive sociological study has yet been made of any community in the Near East or India.

This lack of sociological research may be in part a shortcoming of the social anthropologists who have stuck too closely in their studies to primitive peoples, though for the good reasons that these primitive peoples are fast disappearing and the number of social anthropologists has always been very small indeed. But it is also a fault of the orientalists, whose interests have generally been too purely linguistic, sometimes too purely philological. What is required is closer co-operation between oriental studies and social anthropology, such as has existed in the African field between linguistic and anthropological studies. There are hopeful signs of this development.

It may be expected that the universities will play their part by taking a keener interest in the contemporary world. This does not mean that they will give foremost attention to practical aims in their teaching and research. It is much to be hoped that the Government will allow them an entirely free hand to give broad scholarly teaching and to conduct fundamental research in their own way. Nothing deadens teaching and inhibits research more than direction by a committee of people whose interests are in immediate practical benefits and results. If the aims of the Scarbrough Commission's report are to be achieved, it is essential that whatever committee administers the studentships the creation of which is recommended should choose the men but not the plans of research. It should not draw up a list of projects and try to find men to fit them, but should let each man, chosen on general grounds for his ability and interests, select his own field of inquiry and his own problems within that field without regard to immediate dividends.

Indeed, the Government should look on any expense it may incur in implementing this report not as charity but as a sound investment likely to pay a handsome dividend in goodwill from the peoples of the Far and Near East, Eastern Europe, and Africa, and in the commercial and political benefits which goodwill brings in its train. Nothing endears one people to another more than awareness that its history, language, and culture are a sincere and respectful concern of the other.

RADIO TRANSMISSION LINES AND WAVE GUIDES

Electrical Transmissions in Steady State

By Paul J. Selgin. (Radio Communication Series.) Pp. ix+427. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 25*s*.

The Physical Principles of Wave Guide Transmission and Antenna Systems

By Prof. W. H. Watson. (International Monographs on Radio.) Pp. xiv+208. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 20*s*. net.

THE problem associated with the applications of radio waves to communication, location or navigation is to generate high-frequency alternating currents and convey them from the source to an antenna system which radiates the waves into space. The connecting link between the source and the radiator is termed a transmission line, and for moderately high radio frequencies may comprise a system of two parallel wires, or a coaxial cable or some elaboration of these. At the very high frequencies corresponding to wave-lengths less than a few centimetres in length, this transmission line system takes the form of hollow conductor of circular or rectangular cross-section termed a wave guide. The two books under review deal respectively with transmission lines and wave guides as used in modern radio frequency technique.

Mr. Selgin's intention in the first book is revealed by his definition of a hypothesis of steady state according to which "it is assumed that the amounts of energy transmitted through any junction over two successive equal time intervals, at any particular frequency, are not appreciably different, provided that the period of this frequency is small compared with the intervals considered". It is then pointed out that, though strictly speaking all communication signals must be regarded as transients, it is permissible to adopt this loose definition as a guiding principle for practical purposes.

Nearly half the book is devoted to transmission lines with eight of the seventeen chapters treating uniform non-reflecting lines, distortion, terminal reflexion, power flow, long lines, matching devices, composite lines and stubs and exponential lines. Having this material collected together and coordinated in a single volume is perhaps the most valuable feature of the book, for the treatment is thorough and competent, and this ground is not fully covered in any other single treatise. Emphasis is laid on design problems and on their mathematical solution, particularly with the aid of vector and circle diagrams. The analytical methods required are adequately introduced for a student coming fresh to the subject.

The longest chapter (No. 10, 54 pp.) is that on "Composite Lines and Stubs", which is mainly concerned with the multisection (line) transformer and its optimum design for wide-band transmission and with the selectivity and efficiency of stub tuners. Among the illustrative examples, the effect of the capacity of regularly spaced dielectric insulators in a coaxial cable is considered.

The second longest chapter (No. 14, 40 pp.) gives a full treatment of "Inductive Coupling and Transformers"; and intervalve-coupled tuned circuits are analysed in detail with advantageous use of the parabolic locus method of presenting the results.

Chapters 11 and 12 introduce electromagnetic theory in a manner well suited to the purpose of giving a deeper understanding of circuit and line theory. The clarity and conciseness of these chapters is particularly praiseworthy, as is the refreshing appeal to physical fundamentals which is rare in books intended for engineers.

An attempt is made in the last two chapters to treat valve amplifiers within the general framework of transmission through linear networks, and the gains of the grounded-cathode, grounded-grid and grounded-anode (or cathode follower) amplifiers are deduced. The treatment is rather unsatisfactory and gives the impression of attempting too much in too short a space; the unorthodox graphical symbols and the elaborate vector diagrams also tend to obscure the relatively simple nature of the analysis involved. The book is well printed and only a few errors have been noted. The bibliography is, however, disappointing, for it refers to forty books but only two original papers (both more than twenty years old), and these are not likely to be helpful as many of them are either obsolete or inaccessible to students in Great Britain. Within its scope, which intentionally excludes radiation and wave guides, the book can be recommended to the engineer who is concerned with the design of circuits and transmission lines up to moderately high frequencies, and its treatment is modern and practical without neglect of essential fundamental principles.

Prof. Watson's book is one of a new series of International Monographs on Radio, and is intended to present a description of the manner in which the technique of dealing with radio frequency transmission lines has been extended to propagation through wave guides. When the cross-sectional dimensions of a wave guide are chosen correctly in relation to the wave-length, only one characteristic mode of propagation, the so-called 'dominant wave', is effective in transmitting energy along the guide. The first five chapters of the book give a detailed theoretical treatment of the underlying physical principles of this type of radio wave propagation along wave guides. With the aid of the impedance concept the usual circuit analysis is applicable in many respects to waves along transmission lines as to waves in free space. The problem of wave propagation along a hollow rectangular guide is attacked by an investigation of a system of two interfering trains of plane waves. Chapter 3 contains a useful although brief description of the basic measuring techniques which are essential for any experimental work on wave guides, and includes reference to standing wave detectors, power and phase measurement, and the radiation pattern and gain of antenna systems. The general problem of multiple propagation of waves along guides of either circular or rectangular cross-section is dealt with in the following chapter; it is here that the two characteristic distributions in a wave guide are described. In one of these, termed *TE*, the waves are propagated in such a manner that the electric force is transverse only, while in the other case, of the *TM* waves, the magnetic force is confined to the transverse direction. By an application and extension of Babinet's principle, it is shown in the succeeding chapters how wave guides can be coupled together by means of suitable slots in their sides, and how such slots may also be used to obtain radiation from a wave guide into free space. This portion of the book presents the results of much of the author's original work in recent years in the study and development of slot radiators and antenna systems for centimetre wave transmission and reception. Chapters 8 and 9 discuss in some detail the principles and characteristics of various types of wave-guide arrays and slot aerials, many forms of which have been developed for special applications of radar technique.

In this book, which is well produced and illustrated, Prof. Watson has presented very clearly the results of much original work in elucidating the physical principles of wave guide transmission, the technique of which is likely to play an important part in the applications of very short radio waves in the future. Much of the work in the book is made generally available for the first time, and most of the references given at the end of the book are to papers and reports which have hitherto been classified as confidential. With the rapid publication now taking place in scientific and technical journals in Great Britain and in America, the author should be able to improve this bibliography in a later edition: the opportunity might then also be taken of adding a subject index to the name index which is given at the end of the present book, although the detailed nature of the contents virtually forms a subject index.

R. L. SMITH-ROSE

MODERN CARBOHYDRATE CHEMISTRY

Advances in Carbohydrate Chemistry
Edited by W. W. Pigman and M. L. Wolfrom (Associate Editor for the British Isles: Stanley Peat.) Vol. 2. Pp. xiv+323. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1946.) 6.60 dollars.

THIS volume by no means suffers in comparison with the first in this series (see *Nature* **157**, 676; 1946), and represents a valuable collection of articles setting out the state of knowledge of the subjects selected up to about the end of 1945, the number of references dated 1946 amounting only to six. The choice of subjects is suitably wide, and the articles on anhydro sugars, the analogues of ascorbic acid, the chemistry of mucopolysaccharides and mucoproteins, bacterial polysaccharides and the chemistry of pectic materials are outstandingly good.

In common with the reviewer of Volume 1, I think it is unfortunate that in a publication of this kind detailed experimental work should be included, for great difficulties are likely to arise, especially for abstractors, if the practice is extended. Although none of the British authors is an offender in this respect, the fact that a member of the editorial board has included experimental details in both volumes gives rise to misgivings for the future.

The first thirty-six pages are devoted to an exhaustive memoir by C. S. Hudson on melezitose and turanose. The history of the chemical investigations is described in great detail, and the evidence proving that turanose is 3-α-*d*-glucopyranosyl-*d*-fructose is presented. That experimental evidence is lacking as to whether melezitose contains a sucrose residue is made clear, although many workers will be surprised if this is not the case. The present description of melezitose must, therefore, be 3-[α-*d*-glucopyranosyl]-(?)-*d*-fructofuranosyl-α-*d*-glucopyranoside.

The account by Stanley Peat of the chemistry of the anhydro sugars is noteworthy, and represents a complete survey of this important and fascinating topic. Not only is this article invaluable for reference purposes, but high praise is due for the logical treatment and clarity of style in discussing a complex subject which the author himself has done much to develop.

In the section on ascorbic acid analogues, Fred Smith summarizes the methods of synthesis and properties of these substances, and the hitherto puzzling behaviour of the saccharodilactones is explained by their conversion to reducing enolic forms.

The account by R. Lespieau of the synthesis of hexitols and pentitols from unsaturated polyhydric alcohols is decidedly stimulating to those carbohydrate chemists who, like the reviewer, tend to neglect the possibilities of synthesis on account of the vast field of natural products awaiting investigation.

Harry J. Deuel, Jun., and Margaret G. Moorhouse discuss the interrelation of carbohydrate and fat metabolism in an article covering forty-one pages in which nearly two hundred and fifty references are quoted. This article fulfils one of the objects set forth in the Editors' preface to Volume 1, namely, "It may be found desirable to present several reviews of controversial subjects, particularly in those fields undergoing a rapid state of development".

The extraordinary complexities of the mucopolysaccharides and mucoproteins are discussed by Maurice Stacey in a stimulating contribution which should do much to encourage workers to embark upon researches on these substances. The unusual step of introducing exclamation marks into a scientific article presumably indicates the author's impatience with earlier work in this field; it must be remembered, however, that we stand upon the shoulders of the previous generation even if the foothold seems precarious at times.

Taylor H. Evans and the late Harold Hibbert are responsible for an excellent report on bacterial polysaccharides. I was working with Hibbert in Montreal when some of the investigations described were in progress, and it is a great pleasure to see the results collected together, and to recall the enthusiasm of one whose scientific achievements were not, perhaps, sufficiently appreciated in his life-time.

E. L. Hirst and J. K. N. Jones contribute an account of the chemistry of pectic materials which might well serve as a model for future articles; for the temptation to expand by the full discussion of outmoded earlier results is rejected, to the great profit of the reader.

The polyfructosans and difructose anhydrides are described by Emma J. McDonald in a useful survey of a subject the study of which is beset by many experimental difficulties, and a short survey of cellulose ethers of industrial importance by Joseph F. Haskins reminds the reader of the advances made in a more strictly utilitarian field.

Few mistakes were found in this attractive and useful book, and these principally in the initials of the authors in the references. The practice of printing the Christian name in full for women authors, which indeed is highly commendable, has resulted in an apparent sex reversal (references 30, 65, 103, in the article on bacterial polysaccharides), as those will observe who studied public health chemistry under Dr. E. Ashley Cooper at Birmingham.

E. G. V. PERCIVAL

X-RAY ANALYSIS AS A TOOL IN CHEMISTRY AND TECHNOLOGY

Röntgenographisch-analytische Chemie
Möglichkeiten und Ergebnisse von Untersuchungen mit Röntgeninterferenzen in der Chemie. Von Prof. Dr. E. Brandenberger. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 7.) Pp. 287. (Basel: Verlag Birkhäuser, 1945.) 28.50 Swiss francs.

IN Great Britain, X-ray crystallographers are abundant, and each can afford to specialize. Some of us take to hydrocarbons, others only to carbohydrates, and to others again only the fibrous state of matter appeals. In Switzerland, crystallographers are scarce, and a man who wants to serve university and industrial laboratories alike must be able to master not only all the techniques of X-ray analysis, but also electron diffraction and radiography as well. Prof. E. Brandenberger at Zurich directs such an all-round X-ray laboratory, and in the book under notice he tries to explain to his colleagues the potentialities and limitations of X-ray diffraction.

The title suggests a narrower field than is actually covered, for the book ranges beyond the applications of X-ray analysis to chemistry. As the author explains in the introduction, he does not aim at adding one more to the many text-books on the principles and methods of X-ray analysis—personally I have never found that there was such an abundance—but to review the variety of problems that can be investigated and to illustrate the kind of information that X-ray analysis can provide in each particular case. For all explanations of fundamental principles the author refers to other literature (not even Bragg's law is derived), and only a brief section at the end of the book is devoted to actual crystal structure analysis, including an exposition of some of the more elementary laws of crystal chemistry.

The first part of the book deals with the identification of crystalline phases; this involves the author in the difficulties of defining the term 'crystalline' and leads him to an elaborate classification of lattice types intermediate between the crystalline and the amorphous state. The other sections deal with the analysis of mixtures and multiphase systems, with the study of crystal texture and with reactions in solids. In each chapter the uses of X-ray analysis are rigorously classified and sub-classified, detailed instructions about the preparations of specimens are given, and lists are drawn up of all the different phenomena that might occur and of their interpretation. Some readers may find the absence of any connecting links between the observations and the conclusions to be drawn from them a little disconcerting. It has to be accepted as a statement of fact, say, that lattice distortion causes asterism on Laue pictures or that line-width is an inverse function of crystal size, and no explanation, even qualitative, is offered to the curious about the mechanism involved. Incidentally, workers in Great Britain will probably consider the author to be over-optimistic when he asserts that both the average size of the crystallites and the degree of lattice distortion can be determined from one powder photograph by plotting successively $b \cos \theta$ and $b \tan \theta$ against θ.

There are long lists of references at the end of each chapter; some of those referring to German papers which appeared during the War may be new to readers in Britain. Unfortunately, no author index is provided.

To the university student and to the reader who seeks to understand physical phenomena the book has little to offer; but workers wishing to apply more powerful techniques to the examination of materials and processes might find parts of it useful and interesting, though not very easy to read. Personally, I am inclined to think that the potentialities of X-ray analysis can be judged more easily from a knowledge and understanding of the fundamental physical principles than from a survey of its applications, however painstakingly compiled.

M. F. PERUTZ

LIVESTOCK IMPROVEMENT IN U.S.S.R.

Stockbreeding and the Artificial Insemination of Livestock

By V. K. Milovanov and I. I. Sokolovskaya. Translated by Dr. A. G. Morton. Pp. 160. (London: Hutchinson's Scientific and Technical Publications, 1947.) 25*s*. net.

THIS book presents the Russian point of view on the scientific and practical methods which can be used for the improvement of livestock. Mention of some of their principal local breeds and a tribute to early English breeders is contained in the introduction. Darwin's theories on the causes for variation and on natural selection form the main theme throughout the first two chapters. Correlated variations are illustrated by examples from Russian experimental work which shows the relative proportions of different parts and tissues of the body in different types of sheep (milk, meat and wool) and of cattle (meat, milk and draught). The importance of the creation of suitable environmental conditions in which to make selection of breeding animals is stressed. Many ideas novel to the British breeder are propounded, for example, that nervous activity is associated with body conformation. Pavlov's finding that the 'over fine' animal has weakness in both stimulatory and inhibitory processes is quoted in support of this.

In a chapter on selective breeding 'compensatory matings', that is, mating an animal which has a certain defect with another which is particularly good in this respect, are criticized, while a system of 'homogeneous matings' (like to like) is approved. Breeding methods, such as inbreeding, line-breeding and economic cross-breeding, are discussed, often with reference to English examples.

Perhaps the most interesting chapter in the book is that on the artificial insemination of livestock; the Russian method of insemination by semen-filled paper capsules is described and illustrated. Many of the statements made in this chapter could, with advantage, be backed by full experimental details to support them, since in some respects at any rate they differ from the views usually accepted. For example, it is stated that superabundance as well as insufficiency of spermatozoa has an adverse effect on fertilization. Details are given, however, of selective fertilization of rabbit ova by the inseminated sperm of two different varieties. Methods for testing the quality of the semen are described; but no mention is made of recent methods of insemination developed in the United States and in Great Britain.

A chapter on the maintenance, feeding and utilization of breeding animals contains much useful information on the effects of different feeding-stuffs on semen production, on methods of testing male and female animals for fertility, and on the conditioned reflexes associated with service. The lack of understanding of these latter is a frequent cause of bulls failing to function properly at artificial insemination centres.

In the concluding chapters the development of the young animal is outlined with special reference to the effect of nurture on its development, while observations are also included on the formation of new breeds and the improvement of old ones.

British breeders will find in the book a number of the old, but perhaps now not too widely read, ideas of Darwin on the selection and evolution of animals under domestication, interspersed with many new points of view and observations on reproduction and livestock breeding. JOHN HAMMOND

AN INTRODUCTION TO MODERN PHYSICS

From Galileo to the Nuclear Age

An Introduction to Physics. By Prof. Harvey Brace Lemon. Revised edition of "From Galileo to Cosmic Rays". Pp. xviii+451. (Chicago: University of Chicago Press; London: Cambridge University Press, 1946.) 21*s.* net.

ANY book that aims at presenting a readable account of modern science is to be welcomed, and Dr. Lemon's work on the development of physics from Galileo to the present time has this objective specially in view: Such a study, he claims, should have "something of that human interest that attaches to great personalities, but most of all it should try to show explicitly and implicitly how a great scientific field of thought has come into being. Moreover it should indicate the satisfaction enjoyed by those who participate in such a development of thought, as well as its practical advantages to mankind." Even a cursory glance at this volume shows how far the author has departed from conventional academic form, in order to interest his readers. His colloquial and homely style, together with many well-produced illustrations (sometimes stereophotographs) of a topical and frequently unconventional type, are designed to meet the needs of first-year university students in other faculties who have little background knowledge of the physical sciences. Though based on the curriculum of the University of Chicago, Prof. Lemon's treatment will undoubtedly appeal to similar students elsewhere, and, indeed, to the general reader.

The book is divided into five parts, dealing respectively with mechanics, heat, electricity and magnetism, electricity and matter, waves and radiation. Attention is directed to the underlying importance of the work of Galileo and Newton, and the first part includes successive chapters on work, energy, conservation of energy, power, and concludes with a convincing treatment of the problems of atmosphere and hydrosphere. Prof. Lemon has added to the general interest of his subject by including references to the origin of the Fahrenheit scale, the measurement of temperature by electrical means, and so on: the section on heat ends with a chapter on kinetic theory. Part 3, "Electricity and Magnetism", contains the ground-work study necessary for the appreciation of modern developments. In particular, a helpful approach to 'lines of force' is made by consideration of a gravitational field. In the last two parts of the book, the reader is introduced to an interesting survey of the conduction of electricity through gases, photo-electric and thermionic effects, electrons, radioactivity, electromagnetic waves, and atomic structure. In the part especially dealing with waves, a chapter on sound is inserted.

Though "From Galileo to the Nuclear Age" is primarily a survey of the modern achievements of physics and their dependence on the work of pioneers, the author does not ignore the implications and possibilities of science at this time. "Will man be able in the future so to conduct his political, social, and economic life as to put an end to war and prevent for the future the much greater powers of destruction that soon *all nations* will possess? *Unless this can be accomplished the darkest of all ages surely lies ahead; the rare joy that in the past has gone with the acquisition of knowledge will be known no more.* ... Let us devoutly hope that in some way these problems may be met in time so that future generations again can get some joy from probing still more deeply into the heart of Nature." H. D. ANTHONY

DISSECTION OF THE CAT

Functional Anatomy of the Mammal

A Guide to the Dissection of the Cat and an Introduction to the Structural and Functional Relationship between the Cat and Man. By Asst. Prof. W. James Leach. (McGraw-Hill Publications in the Zoological Sciences.) Pp. viii+231. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 12*s.* 6*d.*

THE choice of a mammalian type suitable for dissection as an introduction to human anatomy and physiology has usually fallen on the rabbit or the rat. The rodent, however, is in many ways less suitable than the carnivore, which is less primitive and is structurally a little nearer to man. We welcome, therefore, this book on the cat as an elementary account of a common and easily obtained mammal.

Constant comparisons with human anatomy and physiology are stressed throughout, and there are many useful summaries. The effects of posture on modifications of structure, especially as regards the upright habit in man, are referred to in an interesting way that makes the book read well, and relieves it from the tedium of names and descriptions so characteristic of the average text-book. At the end of many of the chapters, problems relating to physiology, mechanics of joints and muscles, and surgery are suggested as a stimulus to the future nurse or medical man.

The systems of the body are dealt with in turn, using the injected cat for dissection. Has the author, however, used the just-born kitten instead of the adult cat? For many of the organs it proves much easier, although so much smaller. This is particularly the case with regard to the sympathetic nervous system, which can be demonstrated with ease owing to the relatively large size of the ganglia and the gelatinous nature of the connective tissue. The difference between the fœtal and adult circulations can also be elucidated.

The original line block illustrations are excellent, especially those relating to the skeleton and muscles. The labelling in full is also good. But the half-tone reproductions of drawings by John Trainor do not mix well with the others, and illustrations from other authors have not always been correlated with the text, so that the junior student for whom the book is intended will sometimes find it difficult to recognize the parts under their Latin names. The author's Latin is irregular; foramen ovale changes in the course of the book to foramen ovalis, while fossa ovalis becomes fossa ovale; the plural of plexus is wrongly given as plexi. These are small points that could be corrected in a later edition.

As with all McGraw-Hill publications the book is well produced and the price is reasonable.

N. B. EALES

RESEARCH IN GERMANY ON THE TECHNICAL APPLICATION OF ATOMIC ENERGY*

By PROF. W. HEISENBERG
Max Planck Institute of Physics, Göttingen

EVEN ten years ago, physicists were well aware that the utilization of atomic energy could not be realized without a fundamental extension of scientific knowledge. In spite of the remarkable progress in experimental nuclear physics which followed the introduction of high-voltage equipment and the invention of the cyclotron, no physical phenomenon was known, even as late as 1937, which offered the remotest possibility of exploiting the enormous quantities of energy lying latent in atomic nuclei.

It was the discovery of the fission of uranium by Hahn and Strassmann[1] in December 1938—in other words, the fact that the uranium nucleus can be split into two fragments of comparable mass when bombarded by neutrons—which brought the actual utilization of atomic energy within reach. Following this discovery, Joliot and his co-workers[2] succeeded in proving, in the spring of 1939, that in the act of fission the uranium nucleus itself emits several neutrons, thus making a chain reaction fundamentally possible. Thereafter the possibility of nuclear chain reactions was eagerly debated among physicists, particularly in the United States; in Germany it was discussed by Flügge[3] in *Die Naturwissenschaften* in the summer of 1939. Meitner and Frisch[4] had already directed attention to the enormous quantities of energy set free in the fission process.

Public interest in the problems of atomic physics was negligibly small in Germany between the years 1933 and 1939, in comparison with that shown in other countries, notably the United States, Britain and France. Thus, while in America, previous to 1939, a whole series of modern research laboratories equipped with high-voltage plants and cyclotrons was springing up, in Germany there were only two adequately equipped laboratories; and these were not supported by the State, but sponsored by a private body, the Kaiser Wilhelm Gesellschaft. These two institutes were the Kaiser Wilhelm Institutes at Heidelberg and Berlin-Dahlem; each possessed a small high-voltage set suitable for nuclear research. A cyclotron for such work was altogether lacking—the Heidelberg cyclotron, again built entirely by private funds, and mainly designed for medical investigations, was started as late as 1938, and could not be tested out before 1944. Only with the outbreak of war did the awakened interest of the authorities allow of more extended facilities for nuclear research.

The following report deals with those particular investigations which had for their purpose the technical utilization of atomic energy. The many purely scientific problems which arose in more or less close connexion with the technical problem will not be discussed here; they will be dealt with in a forthcoming FIAT* Review by Flügge and Bothe. I may, however, mention the extensive chemical investigations of Hahn and his co-workers on the fission products of uranium, carried out throughout the War in the Kaiser Wilhelm Institute for Chemistry, the great majority of which have been published.

Almost simultaneously with the outbreak of war, news reached Germany that funds were being allocated by the American military authorities for research on atomic energy†. In view of the possibility that England and the United States might undertake the development of atomic weapons, the Heereswaffenamt created a special research group, under Schumann, whose task it was to examine the possibilities of the technical exploitation of atomic energy. As early as September 1939 a number of nuclear physicists and experts in related fields were assigned to this problem, under the administrative responsibility of Diebner. I should mention the names of Bothe, Clusius, Döpel, Geiger, Hahn, Harteck, Joos and v. Weizsäcker among those so employed. At Schumann's behest, the Kaiser Wilhelm Institut für Physik in Berlin-Dahlem was nominated as the scientific centre of the new research project. The Institute came accordingly under the administration of the Heereswaffenamt; a step which disregarded the rights of the Kaiser Wilhelm Gesellschaft, and so led to the departure of its director, Debye, who as a Dutch citizen could not continue to serve under the ægis of a German war department.

As a result of the first conferences in the autumn of 1939, it was clear that there were two lines of attack possible in the exploitation of nuclear energy. One could attempt the separation of the rare isotope U(235) from ordinary uranium. This isotope, following theoretical arguments due to Bohr, must be immediately applicable either to the controlled production of energy, using primarily the slow-neutron reaction, or directly as an explosive in bombs, using the fast-neutron reaction; the separation of U(235) was, however, a problem which made the greatest possible demands on engineering technique. Secondly, one could mix ordinary uranium with a substance which would slow down the neutrons produced in the nuclear fission without absorbing them. These slow neutrons give rise preferentially to the fission of U(235) and thus maintain the chain reaction. A rapid deceleration of the neutrons is required, in order that the region of resonance absorption by U(238) should be rapidly traversed; for if absorbed they are lost to the chain reaction. The advantage of this arrangement is that the chain reaction can be controlled through the heat developed thereby, so that energy can be abstracted in amounts sufficient for technical applications.

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* This article is a slightly abridged translation of a paper appearing in *Die Naturwissenschaften*.

* FIAT Reviews of German Science, 1939–1946: a series of authoritative accounts of the progress made in both natural and applied science in Germany during the War. These reviews have been sponsored jointly by British, American and French FIAT (Field Intelligence Agency (Technical)), and a limited edition is expected to be ready for distribution before the end of 1947.

† Cf. Smyth Report, p. 27: Initial approaches to the Government. In actual fact, U.S. Government funds were first used at the turn of the year 1939–40 (p. 28), whereas the first discussions between men of science and the American navy took place as early as March 1939.

Thus two lines of purely scientific investigation were marked out: first, to develop refined methods for the separation of isotopes; secondly, by measurement of the effective cross-sections of a range of possible substances, to determine whether the alternative line of attack was at all practicable. Harteck pointed out, as early as the autumn of 1939, that it might be advantageous, in regard to the second scheme, to have the so-called moderator physically segregated from the uranium. This suggestion gave rise to theoretical investigations as to whether, with the effective cross-sections of such moderator substances as were known at the time, an arrangement having a homogeneous mixture of uranium and moderator, or one with a local separation (for example, in layers), led to the more favourable production of energy. A tentative theoretical investigation made by Heisenberg, in December 1939, led to the result that while ordinary water was unsuitable as a moderator, it should be possible with heavy water (D_2O) or very pure carbon to produce energy in positive amount, provided the moderator and uranium were arranged in layers. This arrangement, however, demanded the highest degree of purity of the substances involved. At the same time, it was evident that a certain minimum size of apparatus was necessary for the production of energy. Nevertheless, with a small set it is still possible to determine whether there would be a production of energy if the apparatus were suitably enlarged. Thus if we feed such a small plant with neutrons from an internal source, more neutrons must escape from the surface than are supplied by the source, if the layer arrangement is favourable to energy production; if unfavourable, then fewer neutrons escape than are supplied by the source. These small model plants, which are continuously fed from a neutron source, are called 'neutron-injected piles'. The ratio k of the number of neutrons escaping from the pile to that fed in by the source can be used to characterize the pile. If $k \ll 1$, the arrangement is unsuitable for the production of energy; if $k > 1$, energy will be produced on enlarging the pile.

In 1940, measurements of the most important effective cross-sections were carried out, especially by Bothe and his collaborators, and by Döpel and Heisenberg. At the same time, investigations on the masses and energies of the fission products were being pursued by Jentschke and Prankl[5] and by Flammersfeld, P. Jensen and Gentner[6], and on the spectrum of the neutrons produced by Kirchner and v. Droste and by Bothe and Gentner[7]. The theory of neutron absorption in the U(238) resonance line was laid down by Flügge and Heisenberg. On the technical side the following results were the most important: the absorption cross-section of heavy water proved to be so low that this substance was certainly usable in the construction of a uranium pile (Döpel and Heisenberg). The work of v. Droste on large quantities of sodium uranate, and of Harteck and the Hamburg group—Groth, H. Jensen, Knauer and Süss—on U_3O_8 in solid carbon dioxide, furnished the first criteria for the distribution of neutron density in certain arrangements of uranium and moderator. In the autumn of 1940, the first pile, constructed of layers of U_3O_8 and light paraffin, was built at Berlin-Dahlem and its characteristics measured (Wirtz, Fischer, Bopp). This model pile gave, as expected, $k < 1$, that is, the arrangement was not suitable for the production of energy. Nevertheless, it yielded valuable data for further piles using alternate layers of U_3O_8 and heavy water.

In the summer of 1940, v. Weizsäcker pointed out that a uranium pile, besides generating the fission products of uranium, will constantly produce the uranium isotope U(239) and its transformation series; and that theoretically these transformation products should show the same properties as U(235) in regard to neutron fission. It remained thereby an open question whether β-decay ended at element No. 93 or 94 or even later; for, since no cyclotron was available in Germany, these elements could not be prepared in sufficient quantity for the examination either of their nuclear properties or chemical characteristics. Nevertheless, it appeared likely, from v. Weizsäcker's work, that an energy-producing pile might be used for the production of an atomic explosive, even though the practical details involved remained uncertain. In fact, this method had been employed on the grand scale in America. The American piles deliver as a transformation product of U(239) the element plutonium $^{293}_{94}$Pu, which is used in the manufacture of atomic bombs.

Important technical problems immediately arose out of these scientific investigations. The production of U_3O_8 of the highest purity was assigned to the Auer-Gesellschaft by the Heereswaffenamt. The casting of the corresponding metal powder was afterwards allotted to Degussa in Frankfurt. The production of heavy water, which was obviously of the greatest importance for the construction of a uranium pile, was planned at the Norsk Hydro factory at Rjukan in Norway. Harteck, in conjunction with Süss, H. Jensen and Wirtz, developed a number of projects which resulted in an increase of heavy water production at Rjukan far beyond the former output of 10–20 litres a month. Moreover, Harteck and Clusius put forward detailed plans for the production of heavy water in Germany. The improvements in the Norsk Hydro factory finally increased production in the summer of 1942 to about 200 litres per month. Further, steps were taken by order of the Heereswaffenamt for the production of very pure carbon. The attempts to exceed the degree of purity afforded by the best technical electrographite failed, however, for the time being.

The most important progress in the uranium project was achieved during the year 1941. Initially some negative results were recorded. Thus, the enrichment of U(235) by the Clausius–Dickel thermal diffusion method, using gaseous UF_6, proved impossible (Fleischmann, Harteck and Groth). The absorption cross-section for neutrons of the highest purity electrographite was determined in the Kaiser Wilhelm Institute at Heidelberg (Bothe and Jensen[4]), and the behaviour of pure carbon estimated from the results. It appeared, according to the information then available, that even the purest possible carbon was unsuitable for the construction of a uranium pile; whereas, as is well known, carbon has been used in the United States with complete success. Whether the Heidelberg conclusions were falsified by insufficient consideration of the chemical impurities present in commercial graphite (for example, hydrogen or nitrogen), or by deficiencies in the theory, can scarcely be assessed for the moment. In any event, the Heidelberg experiments on graphite and beryllium (Fünfer and Bothe[5]) made it clear, in connexion with later experiments in the Berlin–Dahlem Institute, that both pure carbon and pure beryllium were highly suitable for use as an outer cover for a uranium pile, inasmuch as their low absorption cross-section and high reflecting power restrict the spread of the neutrons escaping from the pile, thus reducing its minimum dimensions.

In the summer of 1941, 150 litres of heavy water were available for the first experiments on a neutron-injected pile built up of uranium and heavy water (Döpel and Heisenberg, Leipzig). The uranium and heavy water were arranged in alternate spherical layers with the neutron source at the centre. The oxide U_3O_8 which was first employed produced only a slight increase in the number of escaping neutrons, which could scarcely be considered a clear proof that $k > 1$. The use of pure uranium metal, however, gave such a decided improvement that no further doubt of a real increase in the number of neutrons ($k > 1$) was possible (about February or March 1942). Here then was the proof that the technical utilization of atomic energy was possible, and that the mere enlargement of the Leipzig apparatus must furnish an energy-producing uranium pile.

At the same time, important administrative changes were taking place. At a meeting held in the building of the Reichsforschungsrat in Berlin, on February 26, 1942, the results to date were reported to the Minister of Education, Rust, and several directors of war research. The uranium project was transferred from the Heereswaffenamt to the control of the Reichsforschungsrat; and the then president of the Physikalisch-Technische Reichsanstalt, Esau, was made responsible for the project. On June 6, 1942, there was a second meeting at Harnack House in Berlin, when the results of the uranium project were reported to Speer, as Minister for War Production, and to the armament staff.

The facts reported were as follows: definite proof had been obtained that the technical utilization of atomic energy in a uranium pile was possible. Moreover, it was to be expected on theoretical grounds that an explosive for atomic bombs could be produced in such a pile. Investigation of the technical sides of the atomic bomb problem—for example, of the so-called critical size—was, however, not undertaken. More weight was given to the fact that the energy developed in a uranium pile could be used as a prime mover, since this aim appeared to be capable of achievement more easily and with less outlay. As to the separation of the uranium isotopes, no method was known which would have allowed of the production of an atomic explosive without an enormous and therefore impossible technical equipment. Incidentally, the use of protoactinium as an atomic explosive was also considered, since its nucleus is fissionable by neutrons with energies down to 10^5 eV., with the consequent possibility of a fast chain reaction. It was, however, considered to be impracticable to prepare the necessary quantities of the element.

Following this meeting, which was decisive for the future of the project, Speer ruled that the work was to go forward as before on a comparatively small scale. Thus the only goal attainable was the development of a uranium pile producing energy as a prime mover—in fact, future work was directed entirely towards this one aim. Again during the summer of 1942, discussions were held with heat experts on the technical problems of heat transfer from the uranium to the working material (that is, water or steam). Technical experts from the Navy attended the meeting with a view to the possible use of a uranium power unit in warships. The Kaiser Wilhelm Institut für Physik was restored to the Kaiser Wilhelm Gesellschaft, with the author as director. In preparation for investigations on the larger uranium piles planned in the Institute, a spacious underground laboratory was added (Wirtz).

About this time, however, the strain of the War on the already overloaded German industry was making itself felt. Uranium and uranium slugs were produced in such small quantities that deliveries were late and the larger-scale experiments were repeatedly postponed. Nevertheless, important progress was made. As early as 1941, a research group at the Heereswaffenamt (Diebner, Pose, Czulius) had made measurements on a large pile built up as a lattice of uranium cubes in a paraffin matrix; the subsequent theoretical investigation (Höcker) demonstrated that the lattice construction could in certain circumstances show advantages over the layer arrangement. An experiment made by this group with a model pile of uranium cubes in D_2O-ice did, in fact, yield a larger increase in the number of neutrons than the Leipzig pile. In a later experiment, using 500 litres of heavy water, a further increase in the number of neutrons was recorded. Measurements made in the Heidelberg Institute with a small model pile defined the relation between the increase in the number of neutrons on one hand, and the thickness of the layers on the other; while experiments undertaken by Bothe and Flammersfeld at Heidelberg, and by Stetter and Lintner in Vienna, threw new light on the fission processes occurring in U(238). A theoretical investigation by Bothe stressed the importance of the 'stopping distance' (*Bremslänge*) for the minimum size of a self-sustaining pile.

In preparation for further experiments with larger quantities of heavy water and uranium metal, the Kaiser Wilhelm Institut für Physik in Berlin began a study of the effect of graphite and water as an outer cover for the pile. Resonance absorption in uranium had been studied by Volz and Haxel and by Sauerwein. Further, the absorption cross-sections of a series of different substances were measured by Ramm, as well as by Volz and Haxel at the Berlin Technical High School. As regards the question of thermal stabilization of the energy production resulting from the temperature broadening of the resonance lines, experiments by Sauerwein and Ramm with the Berlin-Dahlem high-voltage plant were significant.

In the spring of 1943, the Norsk Hydro electrolytic plant was put out of action in a Commando raid. Its reconstruction was begun, but finally the responsible army command in Norway reported that effective protection of the plant, particularly against air raids, was impossible. In October 1943 the plant was completely destroyed in a heavy air raid. Nevertheless, about two tons of heavy water were available in Germany at the time: a quantity which, according to our calculations, was just enough for the construction of an energy-producing pile. The Reichsforschungsrat had made no effective provision for the construction of a new heavy water factory in Germany, and the pilot plant at I.G. Leuna made slow progress. It was proving, in fact, barely possible, in view of air raids and the overall strain on German production, to undertake such big building projects. The production of uranium slugs came to a temporary standstill after the raids on Frankfurt in the spring of 1944.

Even then, some progress was achieved by the Harteck–Groth–Beyerle group. As early as 1942, this group had succeeded in developing an ultracentrifuge for the enrichment of the isotope U(235). It was planned to use uranium enriched with the rare isotope in the construction of improved uranium piles, possibly in conjunction with ordinary water. At about this time, the direction of the uranium project was transferred from Esau to Gerlach. Gerlach had taken over the physics section of the Reichsforschungsrat, and he strove to promote more particularly the scientific side of the uranium problem; and at that, not only the physical, but also the medical aspect. In connexion with the medical applications, the construction of a low-temperature pile, in liquid carbon dioxide, was undertaken on Harteck's suggestion. Such a pile, even of small dimensions, could be expected to yield profitable amounts of radioactive elements for tracer research, in view of the decreased absorption in the resonance lines at low temperatures.

In the winter of 1943–44, a model pile of 1·5 tons of heavy water and about the same weight of uranium plates was constructed in the Dahlem air-raid shelter through the co-operative efforts of the Kaiser Wilhelm Institutes for Physics in Berlin and Heidelberg (Wirtz, Fischer, Bopp, P. Jensen, Ritter). The number of neutrons injected from the internal source was multiplied by the factor 3, a performance approaching considerably nearer to what we called the *Labilitätspunkt*, at which the ratio k increases beyond limit and at which the uranium pile begins to radiate independently of the neutron source and thus to produce energy. The relation between neutron increase and layer thickness fulfilled expectations. Further, the stopping distances of the fission neutrons in carbon and heavy water were redetermined (Wirtz) and the former inexact measurements considerably improved. These experiments were made in the air-raid shelter of the Institute during the heaviest air raids on Berlin, and were naturally to some extent hindered by the raids. On February 15, 1944, the Kaiser Wilhelm Institut für Chemie received a direct hit. In the meantime, the Kaiser Wilhelm Institut für Physik had been partly evacuated to Hechingen. On the instructions of Gerlach, a cellar cut out of the solid rock, situated in the village of Haigerloch, was equipped for the rebuilding of the uranium pile. It was not until February 1945, however, that the greater part of the necessary material (about 1·5 tons of heavy water, 1·5 tons of uranium, 10 tons of graphite, cadmium for the regulating rods, etc.) was finally assembled at Haigerloch, and a new pile, this time built up of uranium cubes in heavy water, with an outer cover of graphite, constructed (Wirtz, Fischer, Bopp, Jensen, Ritter). A branch of the Reichsforschungsrat at Stadtilm was allotted the remaining quantity of heavy water and a great part of the available uranium. The Haigerloch pile yielded a sevenfold neutron increase. The material available at Haigerloch, however, was just insufficient to attain $k = \infty$. A relatively small amount of uranium would in all probability have sufficed; but it was no longer possible to obtain it, since transport from Berlin or Stadtilm could no longer reach Hechingen. On April 22, Haigerloch was occupied, and the material confiscated by the Americans.

When we compare the German work reported here with the corresponding Anglo-American effort, so far as it has been made known, then the beginning of 1942 seems to be the turning point. Up to that time, both sides were dealing predominantly with the scientific problem as to whether nuclear energy could be utilized at all, and what fundamental methods had to be employed to that end. Both sides had arrived almost simultaneously at very similar results, if one excludes the field of isotope separation, in which the Anglo-Americans had made much greater progress. Furthermore, in the United States far more attention had been given to laying the groundwork for subsequent full-scale development of the uranium project; so that the first self-supporting pile was functioning as early as December 1942.

It remained to determine the technical sequel to these results. In the United States, the final decision was taken to go for the production of atomic bombs, with an outlay that must have amounted to a considerable fraction of the total American war expenditure; in Germany an attempt was made to solve the problem of the prime mover driven by nuclear energy, with an outlay of perhaps a thousandth part of the American. We have often been asked, not only by Germans but also by Britons and Americans, why Germany made no attempt to produce atomic bombs. The simplest answer one can give to this question is this: because the project could not have succeeded under German war conditions. It could not have succeeded on technical grounds alone: for even in America, with its much greater resources in scientific men, technicians and industrial potential, and with an economy undisturbed by enemy action, the bomb was not ready until after the conclusion of the war with Germany. In particular, a German atomic bomb project could not have succeeded because of the military situation. In 1942, German industry was already stretched to the limit, the German Army had suffered serious reverses in Russia in the winter of 1941–42, and enemy air superiority was beginning to make itself felt. The immediate production of armaments could be robbed neither of personnel nor of raw materials; nor could the enormous plants required have been effectively protected against air attack. Finally—and this is a most important fact—the undertaking could not even be initiated against the psychological background of the men responsible for German war policy. These men expected an early decision of the War, even in 1942, and any major project which did not promise quick returns was specifically forbidden. To obtain the necessary support, the experts would have been obliged to promise early results knowing that these promises could not be kept. Faced with this situation, the experts did not attempt to advocate with the supreme command a great industrial effort for the production of atomic bombs

From the very beginning, German physicists had consciously striven to keep control of the project and had used their influence as experts to direct the work into the channels which have been mapped in the foregoing report. In the upshot they were spared the decision as to whether or not they should aim at producing atomic bombs. The circumstances shaping policy in the critical year of 1942 guided their work automatically towards the problem of the utilization of nuclear energy in prime movers. To a German physicist, this task seemed important enough. The mere possibility of solving the problem had been rendered possible by the discovery of th German scientific workers Hahn and Strassmann and so we could feel satisfied with the hope that the important technical developments, with a peace-time application, which must eventually grow out of their discovery, would likewise find their beginning in Germany, and in due course bear fruit there.

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[1] *Naturwiss.*, 27, 11 (1939).

[2] *Nature*, **143**, 470 (1939).

[3] *Naturwiss.*, 27, 402 (1939).

[4] *Nature*, **143**, 239 (1939).

[5] *Z. Phys.* **119**, 696 (1942).

[6] *Z. Phys.*, **120**, 450 (1943).

[7] *Z. Phys.*, **119**, 568 (1942).

[8] *Z. Phys.*, **122**, 749 (1944).

[9] *Z. Phys.*, **122**, 769 (1944).

Publication of results for which no source is cited was prohibited during the War.

A LONG-TERM PLAN FOR THE NILE BASIN

EGYPT, an agricultural country with practically no rainfall, is entirely dependent on the annual flooding of the Nile. Under natural conditions only that part of the country could be cultivated which was reached by the flood waters, and as the bulk of the population was generally little above the subsistence level, a poor flood meant widespread famine. The area of cultivation could only be extended by irrigation of land not reached by the natural flood; that is, by constructing dams to raise the level of the water, without interfering with the maximum level of the flood further downstream. The study of this possibility was begun about 1890 by Sir William Willcocks, as a result of which a relatively small dam was built at Aswan. This was completed in 1902, but was soon found to be inadequate; no other suitable site could be found at the time and the Aswan dam was heightened in 1912. Since 1920 the study of the Nile Basin has been assigned to the Physical Department of the Ministry of Public Works, Egypt, under the director-general, Dr. H. E. Hurst, who has gradually pushed investigations farther and farther upstream to the head-waters of the river in Lake Victoria in Uganda and Lake Tana in Abyssinia. From 1931 onwards a comprehensive series of reports has been issued under the title "The Nile Basin"; the present volume, by H. E. Hurst, R. P. Black and Y. M. Simaika, is the seventh of the series*.

The earlier proposals considered only how to make the best use of the flood water year by year. Storage from one year to another on the Nile itself presented very great difficulties, partly because of the immense volume of storage required to allow for a run of poor floods, and partly because of the enormous loss by evaporation in Egypt. Consequently, a poor flood still caused very great hardship; the situation was not so bad as it might have been because the Nile draws its water from a very large basin, and the fluctuations of rainfall were not in general similar over the whole area; but this advantage is largely offset by the losses in the extensive marshes of the Sudd. The Bahr el Jebel, which carries the whole of the discharge of Lake Albert, averaging 25 milliards (thousand millions) of cubic metres a year, flows through the flat Sudan plain, where it loses nearly half its water by evaporation and transpiration. Owing to this loss, the contribution of the White Nile to the main stream is relatively unimportant, and the bulk of the water supply of Egypt has to be met by the Blue Nile alone.

The population of Egypt is increasing rapidly, and the only way to guard against future famine is to accumulate a reserve of water so large that it can provide against the worst succession of bad years to be expected on any reasonable basis. This reserve must be in regions where evaporation is relatively small compared with that in Egypt, where the volume of water can be increased to a sufficient extent without greatly increasing the evaporating surface, and far enough apart for the variations from year to year to be practically independent, so that runs of bad years would not be likely to coincide in all areas. The authors find that these requirements can be met by dams at Nimule below Lake Albert and at the outlet of Lake Tana, with possibly at a later stage a further reserve in Lake Victoria. The amounts of storage considered necessary, after allowing for the loss of some 40 per cent on the long journey to Aswan, are enormous; they vary slightly according to different details in the plans but roughly amount to 140 milliards of cubic metres in Lake Albert and Lake Victoria together, with afterwards another 40 milliards, and anything up to 17 milliards in Lake Tana. Compared with these figures the capacity of the first Aswan dam, one milliard cubic metres, is indeed "a trifling amount". In order to reduce the losses in the passage of the Sudd, it will also be necessary either to dig a diversion canal or to embank the Bahr el Jebel. The scale of the problem is shown by the length of the proposed canal—about 300 km. or nearly 200 miles. The ramifications are endless, ranging from consideration of the disturbance of dock and harbour facilities to the need to remove and rebuild churches. The cost would be very high, but against it must be set not only the livelihood of many more people in Egypt but also the prevention of flooding and the supply of hydro-electric power. These details are matters for a full engineering inquiry; but the authors have given a lead in what must be one of the most gigantic plans ever seriously put forward.

There is one detail which requires to be mentioned here. The authors repeatedly emphasize their idea of "Century storage", which briefly means that the reserve must be sufficient to deal with the greatest accumulated deficit to be expected in a hundred years. To obtain this figure, they examined a collection of about sixty long records of discharges, river-levels, rainfall, temperature and pressure, ranging from 10 up to as many as 200 years (with one river-level record of 400 years), and plotted the greatest accumulated departures from the mean values against the square root of the number of years. They write: "If we have N observations of an element whose standard deviation is σ, then if R is the maximum accumulated excess or deficit from the mean, on the average

$$R = 1{\cdot}65\,\sigma\sqrt{N}$$

. . . The form of this result is confirmed by theoretical investigations based on the theory of probability applied to the tossing of coins." Unfortunately, they do not give the theory, and the reviewer has not been able to find it anywhere in the literature of statistics; but the form of the expression seems to him to be incorrect. It is easily shown that in a series of values obeying the Gaussian distribution, the maximum possible accumulated departure is $0{\cdot}4\,\sigma N$, but the value of $0{\cdot}4\,N$ is less than $1{\cdot}65\sqrt{N}$ when N is less than 17. Thus, for a series of less than seventeen years, the authors' expression gives an expected departure greater than the maximum possible. Detailed calculation would be difficult; but one would anticipate that the maximum deviation expected in N years would bear a constant ratio to the maximum possible deviation, that is, $c\,\sigma\,N$, where c is a constant less than 0·4. Now the accumulated departures in Plate XII only appear to fit in with the $\sqrt{N}$ law because of one very aberrant figure for 400 years; all the remaining points are fitted much more accurately by the curve given by $R/\sigma = 0{\cdot}2\,N$. In a series of a hundred observations, this gives an accumulated departure 20 per cent greater than that estimated by the authors, and their "Century storage" reduces to 80-year storage. This is not actually a very serious matter, as the uncertainties of some of the other figures are probably equally great, but it might be seized on by opponents.

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* The Nile Basin. Vol. 7: The Future Conservation of the Nile. By Dr. H. E. Hurst, R. P. Black and Y. M. Simaika. (Ministry of Public Works, Egypt: Physical Department Paper No. 51.) Pp. xi+178+27 plates. (Cairo: S.O.P. Press, 1946.) P.T. 125; 25*s*.

So great a plan will require a long time to come to fruition—time which includes not only the building of the great dams and digging of channels, but also the many years required to build up the reserves of water. Everything depends ultimately on the rainfall of the upper parts of the Nile Basin; but the existing knowledge of the amount of rain and its long-term variation has many gaps, especially in Abyssinia, which must be filled by the setting up of new rain-gauges, and this is one of the first necessary steps. So far as one who is not an engineer can tell, Dr. Hurst and his colleagues have considered all that has to be done and the order of priority, and this should be of great help in the discussion of ways and means.

C. E. P. BROOKS

REDUCTION OF FIRE RISKS IN SHIPS

THE Admiralty Chemical Department, Portsmouth, has been busy of late with research into methods of reducing the fire risk on ships arising from paints and other materials used in them. An interim report recently made available reveals that the investigations have followed three lines; namely, the development of fire-retardant paints for interior use particularly on metal surfaces, the fireproofing of textiles, and the fireproofing of plywood and soft timber.

Fire-Retardant Paints for Interior Use on Board Ship

Dried paint films on an organic base can be a powerful factor in transmitting fire, as experience during the War showed. Fire can be propagated from one compartment to another by means of the paint film on the bulkhead between them. Certain paint types when raised to a sufficiently high temperature—on the side of the bulkhead remote from the actual conflagration—blister and form pockets of inflammable vapours. These vapours arise from the partial decomposition of the organic paint medium in the interior of the paint layer. The blisters finally burst, emitting jets of hot gas which ignite spontaneously and burn vigorously, transmitting the fire to any combustible material within reach.

The method used by the Admiralty for evaluating the fire-retardance of paints to be used in such circumstances is as follows. A steel plate, of standard thickness and 12 in. by 12 in. in area, is painted on one side with a primer/top-coat system in the normal manner, adequate time being allowed for drying. The plate is then heated in the vertical position on the unpainted side, with a gas ring supplied with air and gas under standardized pressure. The plate becomes red-hot in about 30 sec. Heating is continued for one minute, by which time combustion of the paint film has largely ceased. Any signs of flashing or flame-propagation are noted, together with any tendency for the red-hot film to detach itself from the plate. This test differentiated decisively between paints of good and bad fire-retardance. Large-scale trials upon painted plates, 6 ft. square, were carried out at the Admiralty Fire Testing Ground, Haslar, and the results established the validity of the laboratory test-procedure.

The tests showed that fire retardance was improved by reducing the proportion of medium so far as was consistent with durability and finish, and that titanium and antimony oxides were particularly effective as pigments in the top coat. The primer used was also important, an aluminium pigmented primer being adjudged to have better fire-retardant properties than a red-lead primer.

A specification for such paints has been prepared which prescribes the type of medium and the minimum proportions of titanium dioxide and antimony oxide to be used, and the correct pigment/medium volume ratio. Fire-resistance and other performance tests are included. Such paint is now in service use, but it has disadvantages, notably its matte surface, and work is at present in hand on the development of a finish of good gloss and adequate fire-retardance.

The experimental conclusion that antimony and titanium oxides are better than the other white pigments tested is interesting, in so far as their behaviour in the heated film must be essentially different; antimony oxide is comparatively volatile and easily reducible on heating with organic matter (such as would be present in the film), and titanium dioxide is particularly inert. Whereas it is admitted that antimony compounds are particularly valuable fire retardants in conjunction with textiles, opinion is divided on the fire-retardant value of antimony oxide in paint; thus an American Report (New York Paint and Varnish Production Club, 1943) on an investigation into fire-retardant paints for steel surfaces says that while in the particular tests reported antimony oxide was useful in preventing flashing in paints of low pigment volume, in paints of high pigment volume (as recommended by the Admiralty) it was the worst of the white pigments examined.

An Inorganic Paint System

Since a paint based on an organic medium can never be entirely incombustible however high the degree of pigmentation achieved, the investigation of paints based on inorganic media was a logical step in the Admiralty investigations. Among the materials examined was cementiferous paint originally developed to make use of the excellent anti-corrosive effect of zinc on steel surfaces and consisting essentially of a zinc oxychloride cement containing a high loading of metallic zinc. Such paint showed great promise as a fire-retardant coating, but in its original form suffered from the following disadvantages: (1) It could not be stored in a ready for use form; it consists of two parts which had to be mixed immediately prior to application. (2) It was highly thixotropic and had poor flow properties. (3) Its colour was a dull grey which could not greatly be improved by the addition of white pigments.

It was found that the first defect could be overcome by the addition of an organic liquid as thinner. Thus 20 per cent by weight of industrial spirit enabled the paint to be kept indefinitely in a ready-for-use condition, and improved the film properties.

To obtain suitable decorative colours, it was, however, necessary to use the cementiferous paint only as an undercoat and to apply a top-coat in the desired shade. It was found that a partially hydrolysed silicon ester painted over a cementiferous primer gave a paint system which was quite incombustible with excellent weather-resistant and fire-retardant properties. When pigmented with titanium dioxide and barium sulphate the film was hard, matte and white; unfortunately, however, the pigmentation was found to affect the film-forming properties of the silicon ester in a discouraging and inexplicable manner. Whereas the pure medium gave continuous, hard and resistant films, the pigmented films tended to craze and crack on drying, and under the fire test small pieces flew off with considerable violence. Usually the cracking resulted in the under-coat being dragged away from the steel surface, and the whole film became faulty and brittle.

The next step was to consider the old problem of plasticizing the silicon ester paint, and di-butyl phthalate was the most satisfactory material. The films, although matte, did not craze or crack on drying or weathering and had excellent fire-retardant properties owing to the fact that the volatile dibutyl phthalate evaporated quickly when heat was applied, instead of charring and burning. Linseed oil was not so successful as a plasticizer.

The remaining problem in the use of silicon ester paints in the manner described was that of stability, for silicon ester medium, whether pigmented or not, shows a gradual increase in viscosity from the date of preparation until, after about three or four months, it sets to a hard gel. The common preserving agents, such as colloidal electrolytes, appear to be ineffective in this case, and the problem is one of great complexity.

The Admiralty has, in effect, met the customary stumbling-blocks in the use of silicon ester paints. Possibly some improvement may lie in the use which has recently been reported of stable silicon esters which are hydrolysed by the user just prior to application. It does not seem unreasonable to suppose that entirely adequate plasticizers for silicon ester will be found in the silicone field.

Fireproofing of Textiles

It was necessary that attention should be paid to the reduction of the inflammability of the many textile fabrics to be found on board ship.

A water-resistant fireproofing treatment is essential for materials such as ships' awnings, boat covers, etc., which are exposed to the weather, and is preferable for materials such as curtains which need to be laundered. Nevertheless a certain amount of fireproofing was carried out on ships by impregnation with water-soluble materials, borax–boric acid mixtures being preferred; reproofing after washing is necessary.

There is no simple method of producing an adequate water-resistant fireproofing treatment by deposition of insoluble inorganic materials in the fibres. Some metallic oxides, for example, iron and tin, which provide efficient flame-resistance when so deposited, unfortunately induce considerable after-glow.

In the Admiralty work the best results were achieved by impregnation with antimony oxide in conjunction with a chlorinated organic compound such as chlorinated paraffin or polyvinyl chloride co-polymer. The after-glow usually associated with such processes was reduced by the incorporation of zinc oxide or stannic phosphate to provide a fire-, water- and weather-resistant process suitable for application to cotton fibres and flax canvases. Large-scale trials demonstrated that the treated fabrics retained a fair degree of flexibility and were very nearly glowproof.

Owing to the somewhat copious evolution of smoke on ignition, it was found that the application of the process on fabrics normally situated between decks was restricted; but for canvas gear, for example, weather screens, etc., more or less permanently fitted on the weather deck, the process was strongly recommended.

In addition to the use of fire-proofing processes, attention was paid to the use of less inflammable textile materials. For example, consideration was given to the replacement of cotton by wool, nylon or alginate according to the circumstances. Glass-fibre fabrics proved insufficiently durable under sea-going conditions.

The report under review, taken with other information, shows that the war years have brought antimony oxide, previously neglected, to the forefront as a constituent of fire-proofing compositions on textiles. Antimony oxide, while of itself having only moderate fireproofing properties (it is not completely inert as suggested by the Admiralty report under notice), has greatly enhanced fireproofing properties in the presence of chlorinated organic compounds (usually attributed to the formation of antimony oxychloride), and also other materials such as iron oxide; and it is as a result of these discoveries that its use has been advanced.

Rapid Methods for Fireproofing Plywood and Soft Timber

In May 1944, work was commenced to devise an efficient method of fire-proofing small wooden articles such as, for example, plywood used in the construction of cases for radio equipment.

The standard method of fire-proofing wood in bulk by impregnation with mono-ammonium phosphate solution was found not to be very suitable owing to the relative slowness with which aqueous solutions are absorbed by wood; and moreover, in the case of plywood, the use of aqueous solutions would cause distortion through attack on the adhesives. This directed attention towards a fire-proofing agent which should be soluble in organic solvents, and in turn led to an examination of the suitability of organic phosphates for the purpose in view. Examination of a large range of materials showed that urea phosphate, which is readily soluble in alcohol, possessed good fire-proofing properties; and an alcoholic solution with a small proportion of wetting agent added was found to give the desired speed of impregnation.

The most satisfactory procedure involved simple immersion of the article to be treated in a hot solution (of 20–30 per cent strength by weight) of urea phosphate in industrial methylated spirits for approximately one hour. The excess was then allowed to drain off, and the article left to dry. Alternatively, though less satisfactorily, in cases where immersion is impracticable, a series of brush applications can be substituted. Large-scale trials at the Admiralty Fire Testing Ground, Haslar, confirmed the efficiency of the process, which has been patented and assigned to the Admiralty.

L. A. JORDAN

NEWS and VIEWS

International Council of Scientific Unions

Executive Committee's Annual Meeting

THE Executive Committee of the International Council of Scientific Unions held its annual meeting in Paris in July at U.N.E.S.C.O. House under the chairmanship of Prof. Němec of Prague. Dr. Laves, deputy director-general of U.N.E.S.C.O., in welcoming the Committee, stressed the importance that U.N.E.S.C.O. attached to mutual international understanding and to the well-being of all the nations of the world. He hoped that the Committee would devote some attention to the social implications of science. Nine international scientific Unions were represented at the meeting, including two new Unions which had been admitted as adhering organisations during the previous twelve months—the International Unions of Crystallography and of Theoretical and Applied Mechanics. A tenth Union was admitted at the meeting, the International Union of the History of Science. No new Joint Commissions between the Unions were formed, but instead it was agreed that one Union should form a committee in a border-line subject and invite other interested Unions to nominate members of the Committee. In the same way, it was agreed to allot each of the existing Joint Commissions to a parent Union, which would be primarily responsible for controlling and helping its activities. The Unions were still feeling their way to the best method of helping forward border-line subjects, but one point was clear—representatives of a particular science should be nominated by the appropriate Union, not co-opted by the parent body. Thus a committee on radio-biology in the Union of Biological Sciences would include members nominated by the Unions of Physics and Chemistry.

The Committee expressed gratitude to U.N.E.S.C.O. for grants totalling more than 200,000 dollars to the Council and the various Unions to meet travelling expenses of delegates, to finance well-established international scientific organisations and to meet certain costs of publication and of administration. M. A. Establier was re-appointed liaison officer between the Council and U.N.E.S.C.O. for 1948. Reports were received from the Unions, Joint Commissions and the Committee on Science and Social Relations. These will be published with the report of the Committee to the organisations adhering to the Council.

Report of the 1946 General Assembly

EDITED by Prof. F. J. M. Stratton, general secretary, the Reports of Proceedings of the Fourth General Assembly of the International Council of Scientific Unions, held in London during July 22–24, 1946 (see *Nature*, August 17, 1946, p. 227), has now been published (London: Camb. Univ. Press, 1946). It includes the presidential address of Prof. H. R. Kruyt and of the proceedings at the general assembly, together with the reports of the international unions. Appendixes include a list of delegates, the report of the executive committee and the draft agreement with the United Nations Educational, Scientific and Cultural Organisation, the financial report, the statutes of the International Council of the Scientific Unions and the scientific unions themselves. The names of the members of the mixed commissions and of the officers of the international unions are also given, making the report a useful reference book; while in addition to the report of the Committee on Solar and Terrestrial Relationships, there is also reprinted the report of the Committee on Science and its Social Relations on the public attitude of scientific bodies with regard to the problems raised by recent applications of science.

The report of the Committee on Science and its Social Relations points out that the problem of nuclear energy takes the foremost place at present in all discussions on the relation between science and society, although biochemistry, biology, bacteriology and aerodynamics will present questions of almost equal importance. Emphasizing that science thrives best in an atmosphere of freedom of thought and co-operation, and that the widest interchange of information is vital to its full development, the report urges that the imposition and control of any necessary restrictions of secrecy should be exercised only by constitutional authority and in consultation with, and under the guidance of, representative scientific opinion. The increasing social importance of science must be recognized by scientific workers themselves as fully as by governments and administrators, and it is part of the duty of men of science to urge that the problems of government and administration should be rationally formulated and attacked. They must, collectively and individually, bring to the solution of these problems their devotion to truth and their unswerving, objective and critical search for facts and their interrelations.

York as a University City

IN a letter dated July 8, 1947, which is addressed to those who have expressed interest in the project of a university foundation in York, the Lord Mayor makes clear the policy being pursued by the University Grants Committee. Although that Committee has expressed agreement with the view "that the City of York is in many respects well suited to be a centre of university education", it has drawn a rigid line between the "short-term" and the "long-term" prospect. It appears that immediate prospective needs can, in the opinion of the Committee, be met by plans for the extension of existing university institutions—"provided they can be assured of additional academic staff in sufficient numbers and of the means of carrying out an extensive programme of new building." Clearly, therefore, the University Grants Committee has already determined that, whether at York or elsewhere, there is little case for the establishment of a new university centre "at any time in the near future". It is, of course, as the Committee points out, open to the local community to proceed to work out the details of a scheme which might form the basis of a long-term policy, should conditions materially change after five or ten years; and it is encouraging to know that an executive committee has already been set up in York to undertake the preparation of detailed plans.

A National Council for Further Education

As a step towards the further implementation of the recommendations made in the report of the Percy Committee on Higher Technological Education, the Ministry of Education has set up a working party to consider the functions and institution of a National Council to co-ordinate the work of Regional Advisory Councils for Further Education. The members of the working party are: Mr. D. R. Hardman, parliamentary secretary to the Minister of Education (*chairman*); Mr. C. N. Gallie, Mr. F. W. Lawe, Mr. S. Hurst, Captain A. M. Holbein, Mr. H. S. Magnay, Dr. J. E. Myers, Prof. E. A. Owen, Prof. R. E. Priestley, Dr. H. Schofield, Sir Charles Tennyson, Mr. T. B. Wheeler, Mr. F. Bray, Mr. H. J. Shelley, Mr. I. O. McLuckie (*secretary*).

Current Aspects of Sociology

THE issue of *Pilot Papers* for March 1947 (2, No. 1), is an admirable mixture of the methodological, the statistical, the philosophical and the human interest in sociology, all of unusual calibre and neatly compèred by Mr. Charles Madge. Two statistical articles illustrate how statistics may lay bare truths obscured by wishful thinking. For example, Mr. J. F. S. Ross shows, as against popular misconception, that the present House of Commons is little younger than previous Houses, and Dr. Grace Leybourn-White that only one in five of those with an intelligence quotient of 124 or more (equal to that of the best half of Manchester students) actually reach the universities. The philosophical contribution by Dr. H. W. Singer (incidentally a statistician) reflects upon social progress, and rightly questions the popular, and sometimes academic, view that economics is wholly concerned with material wealth and prosperity. Human interest is supplied by E. L. Packer's "Aspects of Working-Class Marriage". As a probation officer, he brings wide experience; but clearly the stage is not yet set for even a statistical *estimate* of the relative frequency of the various patterns of marital life he discloses. In Mr. Willson Disher's "Penny Dreadfuls", with many of the original illustrations and three chapters from the "Blue Dwarf", human interest is at highest pitch.

Among the 'coldly' scientific, however, it is the methodological article by Tom Harrisson on "What is Sociology" that will arouse most interest. He cries plague upon both the purely philosophical and deductive, and the purely statistical and inductive approach in sociology. But surely, while deduction and philosophy have little use for mass-observation, statistics are perfectly compatible with it? Statistical measurement is indeed logically the next stage in induction after observation, not a rival method at the same stage. Mr. Harrisson should have every support in insisting on more 'penetrative' observations; but after that, how can mass behaviour be summed up or the relative frequency of its various patterns be estimated except by statistics? While supporting statistics, he should urge that we ought to be less eager to rush into statistics before making sure of the stuff our statistics are made of. Occasionally, too, he is unfair—particularly so to industrial psychologists and sociologists. They are not talking of incentives merely now that it is fashionable, as a new discovery. On the contrary, if Mr. Harrisson will look at the index of books on industrial fatigue so far back as 1923, he will find 'incentives' with many references; or let him read some of the inter-war reports of the Industrial Health Research Board. The industrial psychologist has, in fact, been for many years a voice crying in the wilderness.

German Hydrographic Journal

A NEW journal is to be issued by the German Hydrographic Institute, now at Hamburg, under the title *German Hydrographic Journal*. This will be the medium for the publication of articles on those branches of science which are the concern of the German Hydrographic Institute; such as coastal and open sea surveying, nautical science, navigation, chronometry, terrestrial magnetism, ship's magnetism, nautical technique, tides, and physical and chemical oceanography—the latter including reports on the geology and lithology of the sea-bottom. The *Journal* will, in effect, so far as the subjects named are concerned, take the place of the former *Annalen der Hydrographie und Maritimen Meteorologie*, which were published by the German Admiralty during 1873–91, and thereafter by the Deutsche Seewarte up to 1944. Maritime meteorology and climatology, being now the concern of the Meteorological Office for North-Western Germany, will be dealt with in the new journal only in so far as they affect oceanography. Generally, each issue will contain articles on a variety of the subjects named above, and will include also notices on hydrographic institutions and other related matters. In addition, notices and reviews of publications of interest to the Institute will appear in the pages of the journal, together with a current bibliography relating to the special fields of research enumerated. An ultimate aim is gradually to list all relevant German and other publications which have appeared since the autumn of 1939, though such a bibliography cannot be compiled in proper time sequence. The journal will appear under the supervision of Dr. G. Boehnecke (who is the German director of the Institute), and will be edited by Dr. Arnold Schumacher.

Science in Poland

ACCORDING to a writer, Prof. Adam Malicki, in the new Polish monthly review, *Zycie Nauki*, May 1946, two plans are now being considered in connexion with science in Poland. One envisages the transforming of certain Polish universities (there are seven at present functioning) into higher professional training schools; the other involves an increase in the number of research institutes outside the universities. Past experience is said to have led to the conclusion that the acquisition of knowledge in a certain subject by a student is of less value than the gaining of an insight into the methods of scientific investigation and the solving of special problems. These objects can be best achieved by constant contact with creative men of science and by team-work in research. There may be difficulties in filling immediately all the posts at Polish universities, but their proper functioning is a matter of urgency on account of the large number of students enrolled. Another contributor, Dr. J. Parnas, urges that all research institutes should be placed under the supervision of the Polish Academy of Science and Letters, which should co-ordinate all investigations.

Zycie Nauki, which gives an idea of the outlook for science in Poland, is edited by Mr. M. Choynowski of Cracow, who states that in future the journal will contain a short review in English of scientific life in Poland. In this issue there is a summary of information on atomic energy taken mainly from the *Economist* and *Discovery* and reference is made to the cultural co-operation of the British Council and to its *Monthly Science News* and the *British Medical Bulletin*. Another article, by Stanislaw Liwszyc-Tomasik, is devoted to "the organisation of medicine in Great Britain", which the author thinks has undergone considerable change during the last two or three decades.

Medical Rehabilitation

A BOOKLET published by the Ministry of Health entitled "The Road Back to Health" (H.M. Stationery Office, 1947. 6*d*.; 7*d*. including postage) describes the process called rehabilitation by which injured or sick people are cared for, right from the beginning, with the object of returning them eventually to as full a measure of health and activity as is possible. The booklet tells its story well, and readers of it will be surprised by the degree of useful activity and happiness which can nowadays be conferred upon people whose injuries or illnesses used to cripple them and hasten the end of life. Excellent photographs show patients undergoing this continuous and beneficial treatment, facilities for which are available now at more than three hundred hospitals in England and Wales. Nobody can look at these or read the text of this booklet without commending both the present work and the plans for its future which are outlined in a concluding chapter. The booklet is intended chiefly for hospital authorities, doctors, employers, welfare workers and others closely associated with the care of the sick and injured; but the co-operation of everyone in this work is required, and especially that of the patient, so that the more the general public learn about it the better. The loss of a lung or an apparently irremediable injury of a vital limb or joint need no longer condemn either man, woman or child to be a life-long cripple or dependent on others. Modern medicine and surgery have given us in recent years many spectacular benefits of mankind and most of them have been well and extensively interpreted to the public. Rehabilitation is not so well known or understood. It depends upon the patient and highly skilled co-operation of doctors, nurses and others, and cannot succeed without the active help of the sick or injured person. It is a service to mankind which must be classed as one of the greatest achievements of modern times.

Seismology at Oxford

MISS E. F. BELLAMY, well known for her seismological work, has retired from her post as assistant at the Oxford University Observatory. It is hoped that she will enjoy a long and congenial retirement. The connexion between the Oxford University Observatory and seismology which was effected by the late Prof. H. H. Turner, enhanced by Prof. H. H. Plaskett and cemented by Miss Bellamy and others is being severed. The centre, where the calculations are done before the publication of the International Seismological Summary, has already been moved, by courtesy of the Director of the Meteorological Office, Air Ministry, to Kew Observatory, Richmond, Surrey.

The two Milne-Shaw seismographs belonging to the British Association Seismological Committee have been moved to Charles Darwin's old home at Down House, Downe, Kent (latitude 51° 19′ N., longitude 0° 4′ E.) and put in charge of Dr. O. J. R. Howarth, who, until recently, was secretary of the British Association for the Advancement of Science. Dr. Howarth is setting up the instruments on pillars in the basement of the house and hopes to bring the seismographs into use shortly. Down House is situated on a clay-with-flints cap over the chalk of the North Downs.

Weather Control Predicted

Sky and Telescope for April contains a short note on this subject in connexion with an address by Dr. V. K. Zworykin before the U.S. Institute of Aeronautical Sciences. He pointed out that new electronic calculators will yield rapid results regarding weather forecasts, and it may be possible to alter the weather by the release of a relatively small amount of energy which will have a 'trigger' effect. One method suggested is to spread a large amount of oil on water and ignite it; the resulting updraught would then change the motions of the higher-level air masses. Another method would utilize solar radiation at 'weather control areas', these consisting of large absorbing areas blackened by carbon deposits. These could be easily changed when desirable into highly reflecting areas by the formation of artificial fogs.

Announcements

MR. N. B. KINNEAR, the well-known ornithologist, keeper of zoology in the British Museum (Natural History) since 1945, has been appointed director of the Museum in succession to Sir Clive Forster-Cooper, who retires on October 1.

NATIONAL RESEARCH CORPORATION, Cambridge, Mass., in co-operation with the Division of Industrial and Engineering Chemistry, American Chemical Society, is arranging a symposium on "High Vacuum" to be held in Cambridge, Massachusetts, during October 30 and 31. Attendance will be restricted to technical and scientific personnel concerned with industrial applications of high vacuum. A report and the papers will be published in due course in *Industrial and Engineering Chemistry*. The secretary of the symposium is Mr. Stanley Heck, National Research Corporation, Cambridge 42, Massachusetts.

PUBLICATION No. 15 of Messrs. C. A. Parsons and Co., Ltd., Heaton Works, Newcastle-upon-Tyne 6, is an illustrated four-page pamphlet describing the Sir Howard Grubb, Parsons and Co.'s infra-red gas analyser, the operation of which depends on the fact that most of the common gases have strong absorption bands in the infra-red region of the spectrum. Each instrument is complete with one detecting unit filled with a particular gas, but additional units filled with other gases can be supplied and the replacement made by the user in a minute or two. Gases which can be estimated with the apparatus include carbon monoxide, carbon dioxide, methane, ethylene and other hydrocarbon gases.

WE regret to announce the following deaths:

Dr. John Parkinson, known for his geological work in various parts of Africa, Trinidad, India and Burma, on July 19, aged seventy-five.

Mr. R. I. Pocock, F.R.S., superintendent of the Zoological Society's Gardens, London, during 1904–23, on August 9, aged eighty-four.

Sir William Thomson, professor of mathematics in Victoria College, Stellenbosch, during 1883–95, principal of the University of the Witwatersrand, Johannesburg, during 1924–28, on August 6, aged ninety.

Prof. W. W. Watts, F.R.S., emeritus professor of geology in the Imperial College of Science and Technology, London, on July 30, aged eighty-seven.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Abnormal Flower Development in Barley Involving Sex Reversal

Reports have appeared in the press of widespread sterility in barley grown in East Anglia, and crop failure has been feared. The appearance of 'multiple ovaries' was noted by A. W. Punter, as reported by F. G. C. Fison[1]. Specimens of such abnormal ears were sent to us by Mr. Punter on July 10, which, on examination, disclosed the following facts.

About half the spikelets in the affected ears contained swelling grain and appeared to be normal. The sterile spikelets are easily distinguished from these by the widely opened glumes, exposing one or more undeveloped 'ovaries'. The presence of the rachilla indicates that not more than one flower is concerned. Supernumerary 'carpels' from one to three are present, and there is little doubt that these constitute the staminate whorl of the flower. In various flowers transitional stages were found between normal functional and fertile anthers and completely 'metamorphosed' stamens with many of the characteristics of carpellate structures. In Fig. 1 such a series is pictured. Fig. 1 (*a*) represents a stamen taken from a spikelet of normal aspect with swelling grain; the stamen when examined was nearly empty and had presumably produced fertile pollen. The peculiarity of the stamen is the appearance at the distal end of unusual simple hairs similar to those found normally on the carpel, and thus suggests the first stage of transition from a normal anther to a carpellate structure. In 1 (*b*) the stamen shown has, in addition to the unbranched hairs already referred to, 'stigmatic hairs' at the apex. In this stamen a few pollen grains were seen at the time of examination; but the flower was sterile and the glumes wide open. In 1 (*c*) the transition has proceeded further; there was here no sign of pollen, and the anther lobes are expanded as a white swollen tissue resembling that of the apical portion of a normal ovary. In all these cases the filament is long and thread-like as in the normal stamen, but in 1 (*d*) the filament is shortened and thickened. In 1 (*e*) the 'stamen' superficially resembles a normal ovary, but the ovary wall has not fused at the edges and is a hollow cylindrical sac without trace of an ovule: in no instance so far has any ovule been found in such a 'carpellate' stamen, though it is not absent from the accompanying ovary of the flower.

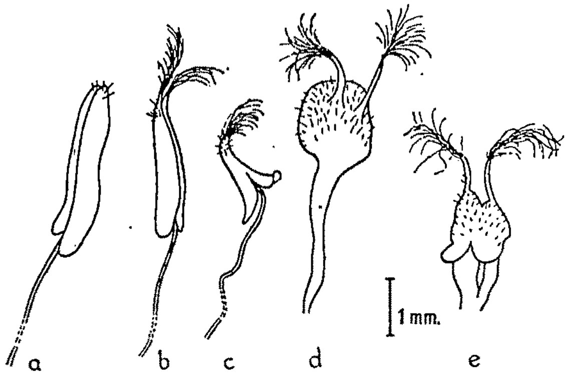

Fig. 1. A SERIES OF STAMENS SHOWING PROGRESSIVE TRANSFORMATION FROM NORMAL TO 'CARPELLOID' DEVELOPMENT

(*a*) Nearly normal stamen with a few simple hairs characteristic of the normal carpel. (*b*) Stamen with normal lobes bearing stigmatic hairs and simple hairs; some pollen formed. (*c*) Stamen with lobes distorted and hypertrophied; pollen absent. (*d*) Stamen with much-shortened and thickened filament and lobes replaced by a shapeless mass of tissue resembling the colourless tissue below the stigma of the normal ovary. (*e*) 'Carpelloid' stamen with flattened filament shortened to a hollow cylindrical sac resembling the ovary wall. Edges of 'filament' unfused

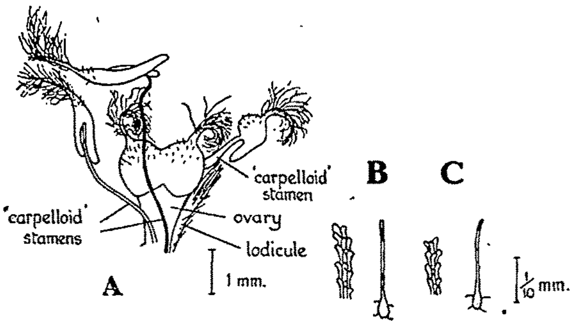

Fig. 2. *A*. COMPLETE ABNORMAL FLOWER SHOWING NORMAL OVARY, THREE CARPELLOID STAMENS AND ONE LODICULE. THE ORIENTATION OF THE STAMENS SHOWS THE ANTERIOR ANTHER TO BE MOST CARPELLATE IN FORM

B and *C*. SIMPLE AND STIGMATIC HAIRS FROM 'CARPELLOID' STAMEN AND OVARY

In Fig. 2 *A* is shown a complete abnormal flower with one of the lodicules, three 'metamorphosed' stamens, and a normal ovary. Fig. 2 *B* shows a 'stigmatic hair' and a simple hair from a carpelloid stamen, and, for comparison, in 2 *C*, similar hairs from the ovary. The identity of the hairs in the two cases emphasizes the resemblance between true ovary and the abnormal staminal structures. Considerable variation occurred in the relative development of the true and 'false' ovaries; in a few cases the structures were of equal size and then indistinguishable in external appearance.

The occurrence of these abnormal flowers was widespread in the barley fields of East Anglia, but similar abnormalities were also observed by Dr. H. K.

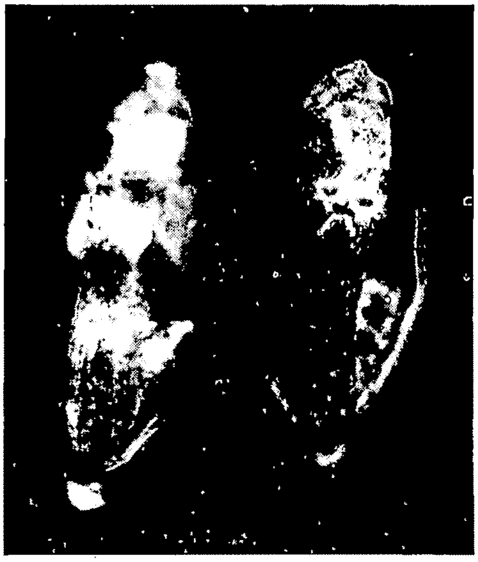

Fig. 3. SWELLING GRAIN TO WHICH IS ATTACHED THE ANTERIOR CARPELLOID STAMEN IN THE FORM OF A 'FALSE' OVARY' WITH WELL-DEVELOPED STIGMATIC SURFACE. (× 5)

Porter in experimental cultures of pure-line Spratt Archer grown at Rothamsted in connexion with other work of the Institute of Plant Physiology. Here the separation of the glumes was very marked, accompanied by bending over of the whole ear. The sterile spikelets were exactly like those described above; but in one open spikelet a normal swelling ovary was found accompanied by two small fruits which, however, contained no seed. Spikelets with swelling grain in abnormal ears showed in nearly every case some distortion of the stamens, some of which, however, must have been fertile.

During the past week, in company with Mr. Punter, one of us has examined the present state of the barley over a wide area of Suffolk. The amount of damage caused by the abnormal flower development was found to be quite small. Many of the sterile flowers have now died off but still show on examination remains of the 'carpelloid stamens'. In spikelets adjoining these, swelling grains were sometimes found in which one of the 'carpelloid stamens' persisted closely adpressed and partially fused with the swelling grain and with the white stigmatic tissue still very evident (Fig. 3). These supernumerary 'carpels' were all sterile, but must have responded to the growth stimulus of pollen which was found adhering to the 'stigmatic' hairs. Quite similar grains have been observed in the material from Rothamsted. It thus appears that if any pollen at all is produced in the spikelet, normal development of the ovary follows by self-fertilization and the glumes remain closed. In cases in which no fertile pollen at all is produced, swelling of the tissue below the stigma separates the glumes, and cross-pollination may be effected. The opening of the glumes, which undoubtedly first directed attention in the field to the abnormal floral structures, appears to be a secondary effect of failure of self-pollination, and not a direct effect of the abnormal floral development. That the ovaries of such abnormal flowers can be fertilized and produce normal grain is undoubted, and in consequence the pessimistic reports of the harvest prospects have fortunately proved in large measure groundless.

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July 24.

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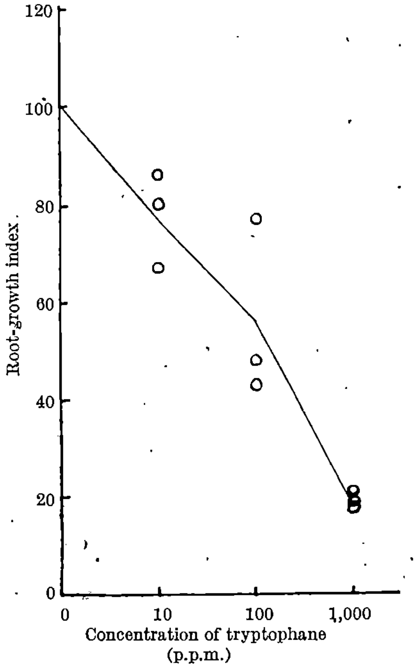
[1] *East Anglian Daily Times*, July 19, 1947.

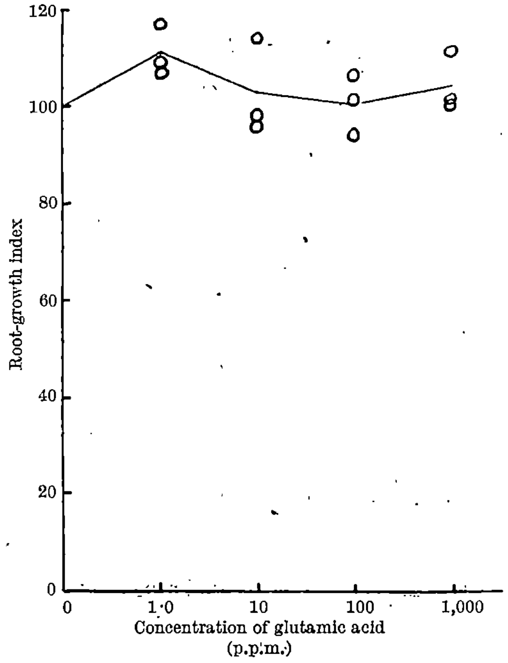
Toxic Effects of Amino-Acids and Amines on Seedling Growth

DURING the course of experiments on the effect of small concentrations of certain normal metabolites on seedling growth in sterile culture solutions, it has become apparent that a large number of amino-acids and amines have a distinct, and in some cases considerable, toxic action on the growth of cress roots. Experiments have been carried out using the technique described in a previous communication[1]. Sterile cress seeds were grown under rigidly sterile conditions in a range of concentrations of the compounds under consideration, together with controls in normal culture solutions. The various concentrations and controls were usually set up in triplicate, samples of 20 seeds being used in each tube. After a period of 7–10 days growth at 20–22° C. in artificial light (9 hours per day), percentage germination and total weight of roots produced were found for each concentration. From these values the root-growth index was determined. This is equal to

$$\frac{\text{Average weight of roots per seedling in presence of inhibitor}}{\text{Average weight of roots per control seedling}} \times 100$$

and gives a direct indication of the degree of inhibition. Graphs were afterwards constructed relating these values to the concentrations of the substances under consideration.





Two such graphs of root-growth index plotted against a logarithmic scale of increasing concentrations of glutamic acid and tryptophane are given in the accompanying figures. From these graphs it will be seen that glutamic acid exerts no toxic action on root growth up to the highest concentration of 1,000 parts per million. There is even the suggestion of a stimulation at the lowest concentration of 1 part per million. Tryptophane, on the other hand, is definitely toxic at 10 parts per million, the inhibition reaching a value of 80 per cent at the highest concentration of 1,000 parts per million. From graphs such as these, estimations of the relative powers of inhibition of a fairly comprehensive selection of compounds have been obtained and appear in the accompanying table.

Substance	Concentration at which inhibition is detectable (in p.p.m.)	% inhibition of root growth at a concentration of 1,000 p.p.m.
dl-α-Alanine	> 1,000	0
l-Glutamic acid	> 1,000	0
Glycine	100	50
Benzoyl glycine	> 1,000	0
l-Aspartic acid	100	15
dl-Proline	100–1,000	30
d-Arginine	100	30
p-Aminobenzoic acid	100	65
p-Acetylaminobenzoic acid	1,000	14
o-Aminobenzoic acid	10	94
o-Acetylaminobenzoic acid	100	81
p-Aminophenylacetic acid	100	75
p-Aminophenylbutyric acid	100	35
l-Tryptophane	< 10	80
Tryptamine (β-indole-ethylamine)	10	51
Nicotinic acid	10	40
Nicotinamide	10–100	35
Urea	100	75

The following points of special interest are apparent from this table.

(1) The only two normal metabolites so far investigated and mentioned in the table that have no detectable inhibitive action on root growth up to a concentration of 1,000 parts per million are α alanine and *l*-glutamic acid.

It is very suggestive that these two acids are highly active in transaminase systems[2,3]. It is not impossible that other amino-compounds may effect their inhibitions on root growth by competitive interference in the normal transaminase systems of the plant. Further experiments are being undertaken with these possibilities in mind.

(2) Glycine, surprisingly, shows a considerable inhibitive action, but this disappears entirely in the substituted benzoyl glycine (hippuric acid), suggesting that the $-NH_2$ group is essentially concerned in the inhibitive action.

(3) This latter suggestion is partially borne out by results from the amino-benzoic acid series of compounds, where the acetylamino-compounds are seen to be definitely less toxic than the parent amino-compounds. There is a possibility that some hydrolysis may have taken place in the solutions of the acetylated compounds, and that the toxic action observed is due to small amounts of the amino-benzoic acids thus produced.

(4) Tryptophane and tryptamine are known to produce certain physiological actions on plants similar to those produced by the auxins[4,5]. It has always been assumed that these effects are due to the formation from these substances of β-indoleacetic acid (heteroauxin) in the plant tissues subject to their action. In our experiments commercial preparations of tryptophane were used, and it is therefore possible that the observed inhibitions may be due partially to impurities in the form of β-indoleacetic acid. On the other hand, it is most likely that the molecules themselves have a considerable toxicity quite apart from the action of any such impurities that may be present.

(5) It is of much interest that molecules such as urea and nicotinic acid have relatively strong inhibitive effects on seedling growth. Conceivably this is connected with the presence of basic groups in the molecules.

To summarize, a most important feature of these results is the fact that many of the inhibiting compounds are normal plant metabolites. This illustrates the complexity of the problems centred around the nitrogen nutrition of the plant. How far these phenomena will enter into questions concerning organic manuring and the specific effects on plants of organic nitrogen molecules in the soil is a subject for future research.

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[1] Audus and Quastel, *Nature*, **159**, 320 (1947).

[2] Kritsman, *Nature*, **143**, 603 (1939).

[3] Cohen, *Biochem. J.*, **33**, 1478 (1939); *J. Biol. Chem.*, **136**, 565, 585 (1940); *Fed. Proc.*, 1, 273 (1942).

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Flowering Responses in a Strain of *Orobanche minor*

AN interesting case of the dependence of flowering on length of day has been found in *Orobanche minor* growing on red clover. In the first place, data obtained by one of us (P. S. N.) suggested that the time of flowering of this parasitic plant was synchronous with that of the host plant, and was to a large extent independent of the sowing date of the parasite. Late-flowering Montgomeryshire red clover seed was sown at six-weekly intervals from November 1945 until June 1946; *Orobanche* seed was added, through glass tubes already in position in the soil, in some treatments concurrently with the clover seed and in others at each subsequent six weeks interval. The November-, January- and February-sown clovers all flowered in early August, the *Orobanche* appearing in August, September and October, almost independently of the time of sowing of the parasite. The April-, May- and June-sown clovers flowered September to October, and the *Orobanche* attached to them appeared at about the same times.

Clover is a long-day plant, and if it is sown either in spring or the previous autumn it normally flowers in July, August and September, according to the earliness of the variety. In order to study the possible influence of day-length on the flowering of the *Orobanche* an experiment was set up (by M. H.) in 1946, in which pots of clover and *Orobanche* sown in February were exposed to 11 and 16½ hours of controlled day-length. The *Orobanche* was planted at a depth of 2 in. in the soil and was not, therefore, itself exposed to alternating light and darkness.

In short days the clover plants remained vegetative throughout the experiment and were compact and small-leaved. In long days they soon became tall and lax with long petioles, and came into flower in July after 106 days of treatment. *Orobanche* inflorescences appeared only in sets exposed to the long days, the first spike after 134 days exposure and two others later. The experiment was terminated on August 15, when the total number of *Orobanche* plants found in each treatment, by washing the clover roots free of soil, was 23 in short and 21 in long days. In short-day treatments none of the *Orobanche* plants displayed any signs of flowering on dissection of the growing apices; but of those from long days, in addition to the three already mentioned, seven plants were found to have flower primordia present.

In 1947 a second experiment entirely confirmed these results. It was further observed that the time of germination of the seed and parasitization by the *Orobanche* were independent of day-length. It thus appears that the *Orobanche* on clover does not initiate flowers unless the host is also in the flowering condition.

The times of flowering recorded in the British Flora of Bentham and Hooker for other members of the Orobanchaceæ are consistent with the view that they, too, are synchronous with their host plants in their time of flowering. This relation, however, cannot be postulated for all parasitic flowering plants, for we have shown that *Cuscuta europœa*, L. and *C. gronovii* Willd. flower independently of day-length and independently of the flowering of the host.

On the assumption that flower initiation in the host is controlled by a specific flowering hormone, this is produced only in long-day treatments, must be present in the root, and either it or a precursor appears to be transferred to the tissues of *Orobanche minor*, in which flowering is induced.

A full account of these experiments is being published elsewhere, and studies of *Orobanche* in controlled day-lengths are being continued.

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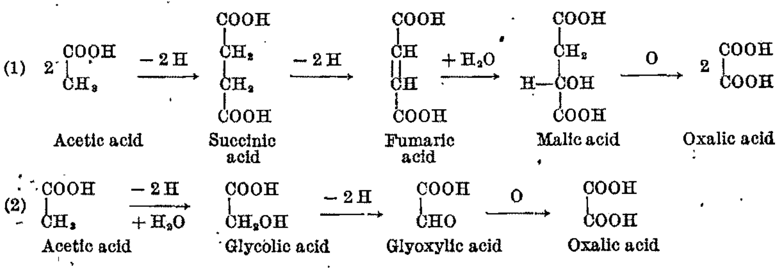
Enzyme Studies on the Mechanism of Wood Decay

Previous studies of the metabolic activities of a group of wood-destroying moulds (*Merulius niveus*, *M. tremellosus*, *M. confluens* and *Fomes annosus*) established the formation of ethyl alcohol, acetaldehyde, acetic and succinic acids by their action on cellulose, glucose and/or xylose[1]. Inasmuch as acetic acid has been shown to be the last breakdown product which can be isolated of the carbohydrate metabolism of these fungi, it was thought of interest to investigate the dissimilation of acetic acid, in the form of sodium acetate, to elaborate the complete phase sequence of wood-cellulose degradation by these moulds.

It was found that oxalic acid is the terminal product of the action of these organisms on acetic acid. The formation of oxalic acid from acetic acid being established, it remained to clarify the pathway of its origin. The discoloration of resazurin when incorporated in the acetate medium, together with a positive test for succinic acid, while pointing to an oxidation of the latter to give rise to oxalic acid, did not exclude the possible simultaneous formation of the acid through another route, since glycolic acid could also be regarded as a dehydrogenation product of acetic acid. Consequently, it was assumed that the discoloration of resazurin indicated a dehydrogenation of acetic acid resulting either in succinic acid, glycolic acid, or both. It would be conceivable, therefore, that *two* pathways can be taken during the formation of oxalic acid from acetic acid, namely:



The action of the *Merulii* and *Fomes annosus* on the following acids was studied: acetic, glycolic, lactic, pyruvic, succinic, fumaric, malic, dimethyl succinic and dimethyl fumaric acids. With the exception of *Merulius confluens*, the organisms were able to produce oxalic acid from all of the acids. It appears, therefore, that the phase sequence of acetate → oxalate transformation proceeds along the pathways outlined above.

Since the same metabolic products (ethyl alcohol and acetic acid) have been obtained from cellulose, glucose and/or xylose by the action of these organisms, we venture to postulate a mechanism for the breakdown of the cellulosic fraction of wood by the action of these moulds. Accordingly the following represents a picture of the sequence of the degradation of cellulose of wood when attacked by these fungi:

Cellulose → Glucose → Ethyl alcohol → Acetic acid → Oxalic acid.

Another mould, *Lentinus lepideus*, also was found to attack wood[2]. On the other hand, we observed that glucose and xylose, too, give rise to methyl-*p*-methoxycinnamate as a metabolic product besides ethyl alcohol during the utilization by this fungus. These findings corroborate the concept of the degradation of the cellulose of wood *via* an introductory hydrolysis when it is decomposed by micro-organisms, since it is only through such a split of the cellulose that glucose can arise as a primary dissimilation product. Then by further action of this mould the synthetic product is formed *via* the free hexose. The facts that xylose (a pentose) also gives rise to the ester, and that ethyl alcohol, obtainable from both glucose and xylose, is rapidly dehydrogenated, prompts the consideration of the transient formation of a C–2 compound in this synthesis which was found to be acetaldehyde. Experiments in which the further transformation of the acetaldehyde was prevented by trapping failed to give rise to the cinnamate.

The similarity between the structure of methyl-*p*-methoxy cinnamate and certain breakdown units of lignin[3] emphasizes the significance of the enzymatic synthesis of the former from acetaldehyde, for the better understanding of the mechanism of lignin formation from carbohydrates in wood, and in the overall progress of lignification.

The best pictures of bacterial nuclei, regardless of whether ribonuclease or hydrochloric acid is used for their demonstration, are obtained with very young cultures, still in the lag phase or at the beginning of the logarithmic phase of growth. At this stage the cells are of maximal size; the nuclei, too, are very large but difficult to demonstrate without pre-treatment because the young cells are very rich in ribonucleic acid and hence intensely basophilic. By contrast, the cells of old cultures are far less strongly basophilic and their nuclei can often be stained directly without the help of any pre-treatment, a fact already utilized by Peshkoff[6]. A possible explanation of the changed staining properties of cells from old cultures may be simply the fact that many bacteria contain a very active ribonuclease, but lack appreciable amounts of desoxy-ribonuclease. For example, a ribonuclease from *Bact. coli*, which we have been able to extract and purify, has proved an entirely satisfactory substitute for pancreas ribonuclease in the demonstration of bacterial nuclei. Thus it may well be that in old cultures, where the majority of cells are dead, bacterial ribonuclease has destroyed the greater part of the ribonucleic acid in the dead cells, leaving the nucleus practically intact. However, this effect is not found in all bacteria, and there are great species variations in ribonuclease content. Thus, *B. anthracis* and the staphylococci contain much less ribonuclease than *Bact. coli*.

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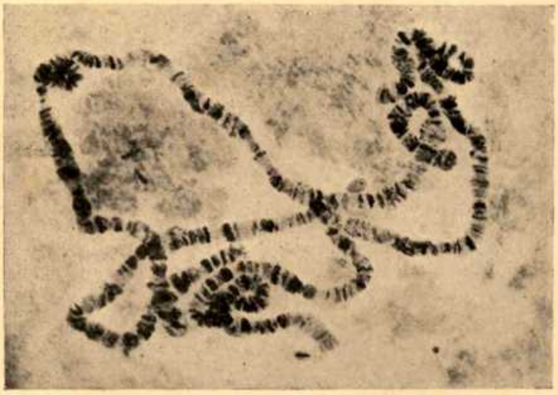
Salivary Gland Chromosomes of *Anopheles*

AN investigation of the salivary gland chromosomes of *Anopheles maculipennis* var. *atroparvus* was begun with the aim of finding out: (1) whether a technique could be produced giving preparations of salivary gland chromosomes, of this and other species, sufficiently detailed for a proper cytological analysis; and (2) if this was possible, whether natural populations exhibit variation in the salivary gland chromosome patterns, and hence comparative karyology might supply an additional tool in the study of geographical, ecological and physiological variation in the genus *Anopheles*.

The first aim was successfully achieved after realizing that a main cause of past failure in obtaining good preparations lay in the conditions (especially nutritional) under which the larvæ were reared. The addition of certain growth factors in the medium proved decisive; the larvæ are now supplied with yeast and *Vorticellæ* in spring water corrected for salinity and *p*H (constant temperature 20–21° C.). The salivary gland chromosome preparations obtained after rearing the larvæ in this way are so clear that a 'map' for *Anopheles maculipennis* var. *atroparvus* has already been drawn. Encouraging results have also been obtained in the second aim, namely, that of variation in the salivary gland chromosome patterns in natural populations. In five instances differences have been found.



PHOTOMICROGRAPH OF SALIVARY GLAND CHROMOSOMES OF *Anopheles maculipennis* VAR. *atroparvus*

Mitotic metaphase plates of *A. maculipennis* var. *atroparvus* show three pairs of chromosomes: two V-shaped and one, the sex chromosomes, rod-shaped. In the females the two rod-shaped chromosomes appear to be connected with two small heterochromatic dots. In the males the heterochromatic dot is smaller in one of the two sex chromosomes, which can therefore be assumed to be the *Y*-chromosome. It is interesting, in this connexion, that Stevens[1] found in *A. punctipennis* four pairs of chromosomes, one of which consisted of heterochromatic material.

The salivary glands of *A. maculipennis* var. *atroparvus* are divided into two lobes. There are about 65 cells in the distal lobe and 21 in the proximal one, the latter giving the best cytological preparations. The salivary gland cells show five chromosome elements connected by a chromocentre. The first of the two V-shaped chromosomes consists of a 'right' arm (II*D*) measuring 96 μ, and a 'left' arm (II*S*) measuring 102 μ; in both arms there are two well-defined zones easily recognizable, besides the two free ends. The second V-shaped chromosome consists of a 'right' arm (III*D*) measuring 116 μ and a 'left' arm (III*S*) measuring 78 μ; there are five easily recognizable zones, two in the III*D* and three in the III*S*, besides the two free ends. The sex chromosome measures 46 μ, and intercalary heterochromatic regions are probably present. This *X*-chromosome appears thicker and better defined in salivary glands of larvæ of females than in larvæ of males. The two heterochromatic dots present in the mitotic chromosomes cannot be identified in the salivary chromosomes.

The five chromosome elements have been carefully mapped, and such maps have made it possible to compare different races of *A. maculipennis*. The analysis of the salivary gland chromosomes of hybrid larvæ derived from crosses between different races could not be carried out during the winter, but is now in progress. Direct comparisons of the salivary gland patterns of *A. maculipennis* var. *atroparvus* with those of the varieties *elutus* and *tipicus* (from Rovigo Province) and *messeæ* (from Pavia Province), all having identical mitotic chromosomes and larval

Detailed accounts of these studies will appear in due course in the *Archives of Biochemistry*.

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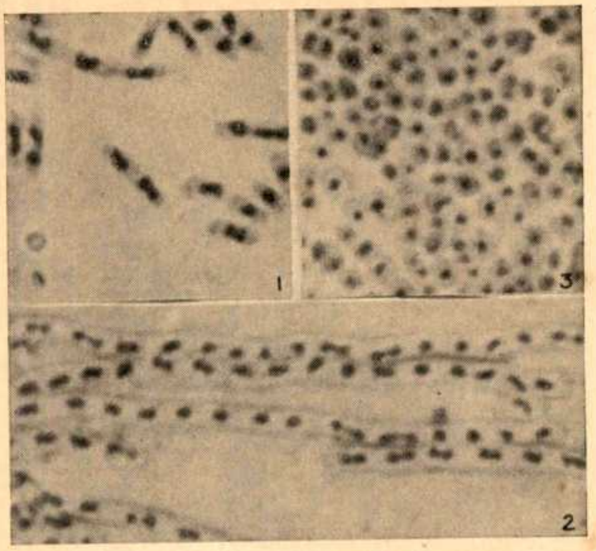
Demonstration of Bacterial Nuclei with Ribonuclease

As part of a general programme of research on the biological significance of nucleic acids in micro-organisms, we have investigated, under the direction of Prof. Boivin, the exact localization of ribo- and desoxyribo-nucleic acid in bacterial cells. Cytological observations of the last decade have furnished convincing evidence of discrete nuclei in many species of bacteria. A method that has been much used to differentiate the nuclear structures from the strongly basophilic cytoplasm consists in treating suitably fixed bacteria with warm hydrochloric acid, followed by staining with Giemsa solution[1]. Using chemical methods on bacteria in bulk, one of us demonstrated[2] that the success of the hydrochloric acid – Giemsa method is due to the fact that ribonucleic acid is removed more rapidly from the cells by hydrochloric acid than the desoxy compound. In view of this result, and of what is known about the distribution of the two types of nucleic acid in the cells of higher organisms, it is plausible to assume that in bacteria, too, ribonucleic acid is located in the cytoplasm, the desoxy acid in the nucleus, and that the high ribonucleic acid content of bacteria (10–15 per cent in cells from the end of the lag phase and the beginning of the logarithmic phase[3]) is responsible for the strongly basophilic character of young bacterial cells and the difficulties encountered in demonstrating their nuclei by conventional staining methods.

We have put this hypothesis to the test by studying the action of ribonuclease on bacteria[4]. By treating fixed bacteria with purified preparations of ribonuclease it is possible to suppress the affinity for basic dyes shown by the bacterial cell as a whole, leaving in its interior a chromophilic body which presents various aspects of constriction and division and is obviously the nucleus already seen by the earlier workers. (More recently, we have found that it is possible to suppress the affinity for basic dyes of not only the cytoplasm but also the nuclei by the successive action of ribo- and desoxy-ribonuclease.) The localization of ribonucleic acid in the bacterial cytoplasm is thus established, and the method gives, in addition, very convincing pictures of bacterial nuclei. The choice of the fixative proved very important in obtaining clear-cut results of enzyme action. Alcohol alone has given us poor results, formalin alone much better ones; in the end we decided in favour of Chabaud's[5] mixture of alcohol 80 per cent (60 ml.), phenol (15 gm.), formalin (5 ml.) and acetic acid (2 ml.), which has given consistently good results with a variety of materials. Osmium tetroxide, excellent as a fixative in connexion with the hydrochloric acid – Giemsa method, cannot be employed for preparations which are to be treated with ribonuclease, since osmium interferes with the action of the enzyme. The ribonuclease which we used was prepared from pancreas with slight modifications of the techniques of Kunitz and Dubos. Heating this preparation to 100° C. removes all traces of the heat-labile desoxy-ribonuclease but leaves the activity of the ribonuclease unimpaired.



NUCLEI IN *Bact. coli* (FIG. 1), *B. anthracis* (FIG. 2 AND *N. gonorrhœæ* (FIG. 3) STAINED WITH GIEMSA SOLUTION AFTER PRE-TREATMENT WITH RIBONUCLEASE. Mag. × *c.* 3,000

To demonstrate nuclei, fixed films of bacteria were treated for several minutes with a 2 per cent solution of ribonuclease at 60° C., rinsed with water, stained with Giemsa solution and examined after drying.

Extraction with ribonuclease has enabled us to demonstrate nuclei in various stages of division very clearly in many different strains of *Bact. coli* (Fig. 1). In agreement with earlier workers we found single, central nuclei in some of the cells, regularly spaced groups and chains of nuclei in others. Very clear pictures of nuclei were also obtained after ribonuclease treatment of vegetative cells of *B. anthracis* (Fig. 2). In *C. diphtheriæ*, of which we examined a strain distinguished by the almost complete absence of metachromatic granulations, we met with a bewildering variety of nuclear configurations. We are now trying to ascertain whether any correlation exists between the different cytological appearances and the growth-cycle of this organism. We have also seen well-defined nuclei in enzyme-treated gonococci in pus and in pure culture preparations (Fig. 3). Pyogenic staphylococci proved very resistant towards ribonuclease and extraction with hydrochloric acid, although the chemical analyses carried out by one of us[2] show that staphylococci contain large amounts of the same ribo- and desoxy-ribonucleic acids that are found in other bacteria. To explain this unexpected result we must perhaps assume that in these organisms there exist special compounds of ribonucleic acid with the proteins of the cytoplasm, and that ribonuclease can only attack the free but not the bound nucleic acid. We are now experimenting with various pre-treatments (alkali, etc.) with the view of preparing resistant organisms for the action of ribonuclease, and have already obtained some encouraging results.

and imaginal characters, show that: (1) *elutus* has two inversions, a small one in the *X*-chromosome and a larger one in the left arm of chromosome III; (2) *tipicus* has a large inversion in the right arm of chromosome III; (3) *messeæ* has a small translocation and a small inversion in the X-chromosome, and a large inversion in the right arm of chromosome III. All these arrangements are homozygous in each variety.

A comparative analysis is at present in progress with *A. bifurcatus*, the mitotic chromosomes (two V-shaped and one dot) of which differ from those of *maculipennis*. In the gangliar cells and in the resting stage of the germ cells of *bifurcatus* the heterochromatin is almost lacking. The salivary chromosomes of *bifurcatus* are different from those of *maculipennis*, though some similarity of pattern can be recognized in certain regions near the tips. It seems possible that the total or partial sterility of the inter-racial hybrids within the *maculipennis* species is correlated with the chromosomal rearrangements described here, and that the *bifurcatus* salivary chromosome pattern is derived from one similar to that now represented in *maculipennis*.

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[1] Stevens, *Biol. Bull.*, **20**, 109 (1910–11).

Histamine as a Physiological Activator of the Reticulo-Endothelial System

MY investigations since 1940 have led to the conclusion that histamine plays the decisive part in the phenomenon of phagocytosis. My experimental work has shown that histamine is able to transform resting endothelial cells into active phagocytes. It is histamine which, as the physiological activator, induces phagocytic activity of the whole reticulo-endothelial system.

If, for example, a histamine solution is painted on the skin of rats and Indian ink then injected into their blood, the smeared areas show grey spots; one can indeed 'write' with histamine on the skin. Through its influence the endothelial cells, especially in the small veins, are transformed to phagocytes and adsorb and accumulate the Indian ink just as reticulo-endothelial cells do. Injected histamine has a general 'activating' effect, for example, in mice, rats and guinea pigs, changing the endothelium of the small veins in all the striated muscles and in the wall of the duodenum into reticulo-endothelium.

This effect of histamine on the endothelial cells can be inhibited by: (1) increasing the tolerance of the animals to histamine, which in mice and rats is easily accomplished by daily repeated histamine injections (rising to 5–10 mgm. subcutaneous doses); (2) preliminary treatment with an anti-histamine agent, for example, Meier and Bucher's antistine[1] (2-(N-phenyl-N-benzyl-aminomethyl)-imidazolin), the specific effect of which is histamine-antagonism.

My experiments with this anti-histamine substance prove that the same characteristic activating effect of histamine keeps the actual reticulo-endothelial system in continuous activity. In the living animal the antistine vigorously curbs, or even stops, the phagocytic activity of the reticulo-endothelial cells. I have demonstrated the inhibiting effect by a new method, worked out with L. Szalay, for the continuous quantitative determination of the activity of the macrophage system.

We injected mice and rats intravenously with Indian ink stabilized with gelatine, which circulates in the blood without a decrease in dispersion as long as the phagocytes accumulate it quantitatively. From a cut at the end of the tail we took 2–3 drops of blood every five minutes, absorbing it on filter paper so that it formed spots about 1 cm. in diameter. After drying, these pieces of filter paper were immersed in slightly alkaline water, in which the blood pigment dissolves, while the Indian ink remains adsorbed in the tissue of the paper. Thus we get a series of gradually paler black-grey homogeneous spots which clearly show the progressive elimination of the Indian ink. We determined the darkness of the Indian ink spots by objective photometric determination of the light reflected by the spot on to a rubidium photocell and measuring the photocurrent by means of a string electrometer. Thus we can calculate the percentage of the light reflected by the clean paper absorbed by the stained spots, and these numerical values represent precisely the process of Indian ink elimination. From data from animals pretreated with large doses of antistine, it appeared that the anti-histamine vigorously hindered, indeed temporarily almost entirely stopped, the Indian ink phagocytosis and greatly extended the elimination time.

That the cause of this inhibition by antistine is really a competitive antagonism between histamine and antistine in the reticulo-endothelial cells themselves was proved by experiments on surviving rat-livers, through which colloidal gold or Indian ink was perfused in 38° C. in Ringer–Locke solution containing 6 per cent human blood serum. While in the control experiments the Kupffer cells filled up in 50 minutes with the accumulated colloid, the antistine in 1 : 2,500 concentration so completely paralysed the phagocytes that they remained empty. The simultaneous addition of histamine to the same concentration, however, overcomes the antistine-inhibition and restores the Kupffer cells to their normal activity. I interpret these experiments as meaning that the two compounds of related structure compete on a mass action basis for one and the same receptor of the mesenchyme cell, the receptor to which histamine has to be bound to produce the phagocytic function. The reticulo-endothelial cells work under the constant influence of histamine, the place of origin of which is unknown.

My investigations indicate that, as the actual agent of phagocytosis, histamine—that is, its liberation—has a central role in the defensive and recuperative reactions of the organism. Its role in inflammation is primarily explained by its phagocyte-activating effect. The liberation of the latent histamine in the tissues through different physical and chemical influences is a purposeful process: in consequence of its effect the place of the lesion is immediately surrounded by an active reticulo-endothelial zone. Mechanical injury or substances causing inflammation, for example, allylisothiocyanate, also change the endothelium of the vessels into reticulo-endothelium. These indirect activating effects can also be inhibited by desensibilizing histamine treatment or by a previous antistine injection.

A detailed description of these investigations will be published elsewhere.

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[1] Meier, R., and Bucher, K., *Schweiz. Med. Wochschr.*, **146**, 294.

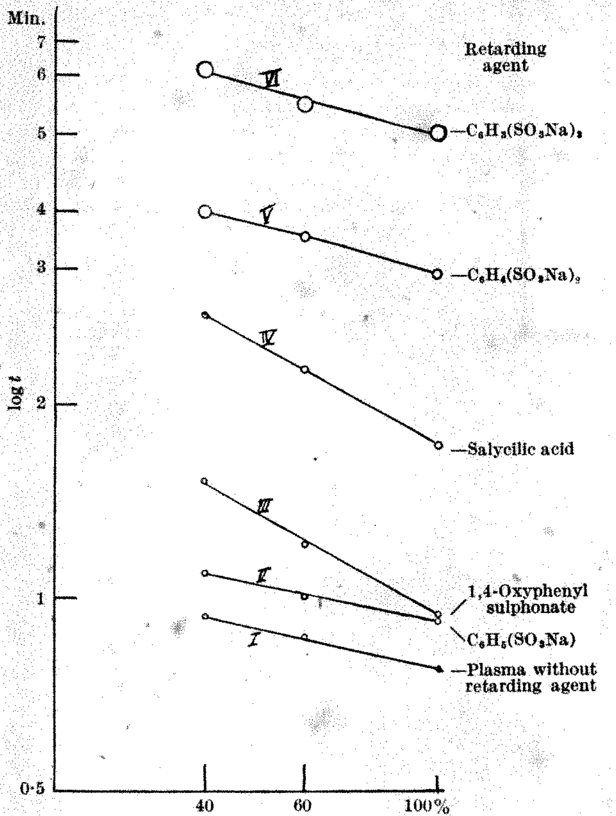
Influence of Hydrotropic Substances on the Sol/Gel Transformation of Blood Plasma *in vitro*

JORPES[1], studying the chemistry of heparin, and, before him, Demole[2] and Fischer[3], have insisted upon the importance of the —SO_3H group for the inhibition of blood-clotting. Link *et al.*[4] have proved that salycilates have an antiprothrombinæmic effect, which is about twenty times weaker than the equivalent dose of 'Dicumarol' (Quick[5], McKennie[6]). In order to get comparable data between the retarding influence on blood-clotting and the chemical constitution, we have measured the effect of the following hydrotropic substances *in vitro*: the sodium salts of phenyl-sulphonic acid, 1,4-oxy-phenyl-sulphonic acid, salycilic acid, 1,3-phenyl-disulphonic acid, 1,3,5-phenyl-trisulphonic acid. The method consists in mixing in small test-tubes 0·1 ml. of normal oxalated blood-plasma (human) with 0·1 ml. of a mixture of phosphate buffer and hydrotropic substance, and 0·2 ml. 'Thromboplastin' (Hoffmann-LaRoche, Basle). The phosphate buffer consists of $M/30$ potassium dihydrogen phosphate and disodium hydrogen phosphate, so as to give a pH of 7·2. It contains, further, sufficient hydrotropic substance to make it one third molar.

Series of four test-tubes containing analogous mixtures are placed in a water-bath at 30° C. After two minutes 0·2 ml. of $M/40$ calcium chloride are added (time 0) and carefully mixed. Thus the volume of the final mixture is 0·6 ml. and the concentration of the retarding substance therein is $M/18$. The four test-tubes are then mechanically waved (not shaken) in the thermostat at 30° C., up to the time when the solution moves no longer as a liquid but becomes a firm gel. The moment when the sol/gel transformation is complete is sharply defined and takes place within 3–4 sec. for all the four test-tubes. In order to test the reproducibility, we have repeated the four-tube series three times. We found a variation of times within $\pm$ 1·5 sec. so long as the sol/gel transformation takes place in less than 2 min., and $\pm$ 2·5 sec. when the process takes longer. Besides the times for undiluted plasma we have also measured plasma-dilutions with saline of 60, 50 and 40 per cent. If we plot the logarithmic values of these dilutions (c) against the logarithmic values of the times (t) measured, the results give a straight line, the equation of which is

$$t = k \times c^{-a} \text{ (compare Legler}^{7}\text{).}$$

The lowest line (I) is obtained without addition of a retarding substance. If we compare the time gained with undiluted plasma with the times retarded by addition of $C_6H_5SO_3Na$ (II), $C_6H_4\,(SO_3Na)_2$ (V) and $C_6H_3\,(SO_3Na)_3$ (VI), we find a proportion of 1 : 1·23 : 4·37 : 7·56. The retarding effect of two SO_3Na-groups instead of one is, therefore, 3·14, and the effect of three such groups instead of two is 3·19. The three sulphonates which were tested have a different parameter k but the same exponential factor a, as their lines have the same angle with the base line. It is noteworthy that both the lines of 1,4-oxyphenyl-sulphonate (III) and of salycilic acid (IV) have a different k and a from the three sulphonated products. The retarding effect of the five hydrotropic substances which were evaluated increases in the same order as the substances as listed above. Our results are a new proof that the more SO_3Na-groups are present in the molecule of an aromatic substance the more efficient they become in retarding the clotting process of blood plasma *in vitro*. Their action, insignificant *in vivo*, is ascribed to the very small molecular weight, compared with those of heparin and the different synthetic polysulphuric acid esters. Therefore, their concentration in the blood-stream is diminishing too rapidly.



TIME OF PLASMA SOL/GEL TRANSFORMATION

The radius of the circles gives the precision with which the time of the plasma sol/gel transformation can be reproduced. With increased prolongation of the clotting process, the reproducibility tends to become less exact

The measurement of the sol/gel transformation time with 1,4-oxyphenylsulphonate as a retarding agent is of such precision that we have founded upon it a routine procedure for the clinical laboratory. Details of results are in the press and will be published elsewhere.

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Cushion Cells in Retinal Pre-capillaries and Capillaries

I HAVE observed large cells of the intimal layer of retinal arterioles, capillaries and venules situated mostly at vessel branches. These cells reduce the lumen to a narrow slit or occlude it completely. The protoplasm of these cells is granular and gives them an appearance different from that of the other intimal cells. These cushion cells are best visible unstained in glycerine-cleared retina with reduced illumination.

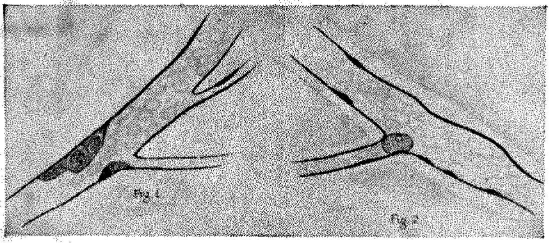

Fig. 1. CUSHION CELLS IN A RETINAL VENULE. UNSTAINED. × 225

Fig. 2. CUSHION CELL IN AN ARTERIAL BRANCH. UNSTAINED. × 225 RETINA IN BULK, CLEARED

They have been stained with azo-eosin in bulk. I was unable to discover them in stained paraffin sections. The dehydrating process seems to cause a shrinkage, which makes the cushion cells indistinguishable from other intimal cells. It is probable that these cushion cells regulate the retinal blood stream within the fine branches according to need.

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Unusual Flame Gases

HYDROGEN–AIR mixtures containing less than about 20 per cent hydrogen when burnt at an orifice undergo two highly contrasted modes of combustion which result in flame gases of very different types. In our experiments well-mixed mixtures of hydrogen and air contained in a tank were supplied to a burner in the form of a long narrow slit, the width of which was 1/16 in. The temperatures attained by very fine platinum–rhodium wires (0·0005 in. diameter) and by quartz-covered platinum wires (0·0005 in. overall diameter) were measured at some two hundred points in the flame gases. A contour map of the platinum wire temperatures in the lower portion of the flame gases resulting from the combustion of a 14 per cent mixture is shown in Fig. 1. These results are summarized in Fig. 2 and extended to a flame height twice that shown in Fig. 1. The temperatures measured by the quartz wire were almost exactly the same as those measured by the platinum wire, except in the early stages after combustion at the sides of the combustion zone (see dotted curves, Fig. 2).

From Fig. 2 it will be seen that after a prolonged interval (which decreases as the mixture strength is increased) the wire temperature attains a steady value, indicating that the flame gases have attained a state of equilibrium. The steady temperature is some 130° C. below the calculated temperature (1,140° C.), and, as the radiation losses are known to be small, this suggests that the flame gases in this state contain in very stable fashion an unreleased energy[1,2] amounting to at least 10 per cent of the heat of combustion.

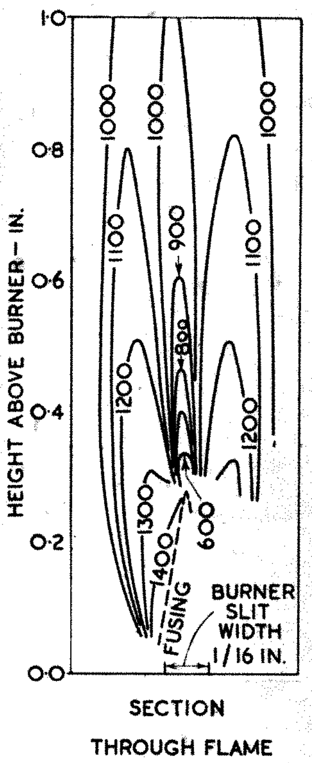

Fig. 1

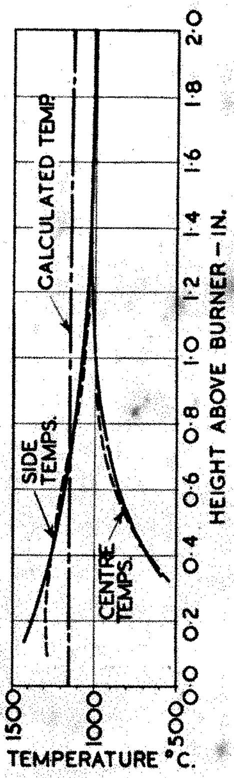

Fig. 2

But we wish to direct attention especially to the state of the flame gases during the interval before the attainment of equilibrium. First take the central gases. It will be seen that immediately above the peak of the combustion zone the temperature measured by both the platinum and the quartz wires is less than 600° C. (which is more than 500° C. below the calculated temperature). This temperature gradually increases until the steady temperature of 1010° C. is reached. Flame photographs show that little, if any, luminosity (or ultra-violet radiation) is emitted by these gases, or indeed by the peak portion of the combustion zone from which they emerge. (We could only infer the position of the peak portion by the fusing of the platinum wire, as a result of surface combustion, as it was brought down into the unburnt gaseous mixture—see dotted curve, Fig. 1.) It seems possible that the cause of this curious type of combustion is a pre-treatment of the unburnt mixture during its travel upwards between the two intense side combustion zones (see below). The low temperature of the flame gases does not seem to be due to the formation of hydrogen peroxide, and we suggest tentatively that it may be due to temporary linkages of water molecules (as in the case of superheated steam near the saturation temperature).

In the case of the side flame gases, the platinum wire temperature is as much as 200° C. greater than the calculated temperature, and, very surprisingly, the temperature attained by the quartz wire is just as great—except in the very early stages after combustion. These gases and the intense side combustion zones are readily photographed. If it may be assumed that atomic oxygen, unlike atomic hydrogen, combines equally efficiently on quartz as on platinum, it would seem clear that large quantities of atomic hydrogen are present in the flame gases as they leave the combustion zone, and that these react with oxygen to form atomic oxygen ($H + O_2 = OH + O$). Accepting this hypothesis, other experiments indicate that this reaction proceeds more slowly in flame gases at lower temperatures and more rapidly in flame gases at higher temperatures.

It is of interest to add that the wire temperature map is completely changed when some of the hydrogen in the hydrogen – air mixtures is replaced by carbon monoxide, and also when hydrogen is substituted for the excess oxygen present in the hydrogen – air mixture.

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[1] *Proc. Inst. Mech. Eng.*, **151**, 236 (1944).

[2] *Nature*, **154**, 115 (1944).

Second-Order Raman Spectra of Crystals

USING the smaller Hilger quartz spectrograph and the λ 2536·5 radiations of the mercury arc as exciter, tests were made to determine the minimum exposure times required to bring out the various features observed in a fully exposed Raman spectrum of diamond. The line with a frequency shift of 1332 cm.$^{-1}$ appeared on the plate with an exposure of only five seconds. Half a minute was needed to record the Brillouin doublet centred about the exciting radiation, the latter itself being filtered out by a mercury vapour screen. An exposure of half an hour sufficed to record the second-order Raman spectrum, while the anti-Stokes frequency shift of 1332 cm.$^{-1}$ appeared after forty-five minutes. An exposure of three hours results in heavily over-exposing the second-order Raman spectrum, but is useful in bringing out clearly the weak terminal line having a frequency shift 2015 cm.$^{-1}$, which is liable to be overlooked with smaller exposures. (This line and its more intense neighbour at 2176 cm.$^{-1}$ are of special interest as they appear with great intensity in the infra-red absorption spectrum of diamond.) Longer exposures up to ten hours reveal no new features. It is very significant that no hint or trace of the continuous spectrum of elastic vibrations forming the so-called 'acoustic branches' of the lattice spectrum of the crystal appears on the plate even with the longest exposures. This will be evident from a comparison of Fig. 1 (*a*) and 1 (*b*), the former being the spectrum of the mercury arc and the latter the spectrum of diamond recorded with six hours exposure.

The great disparity of behaviour which these observations disclose between the parts of the vibration spectrum in the upper and lower ranges of frequency is intelligible only when we recognize the fundamental difference in their nature. The acoustic spectrum has its origin in the propagation of elastic waves through the crystal from end to end, while the infra-red vibrations are evidently not 'waves' but eigen-vibrations of the individual units of the crystal structure. The experimental facts recorded here, and the discrete line structure of the second-order spectrum illustrated in an earlier communication[1]) (see also the accompanying photomicrometer record (Fig. 2)), are in my opinion conclusive evidence of the correctness of the theory of the vibration spectra of crystals put forward by Sir C. V. Raman[2].

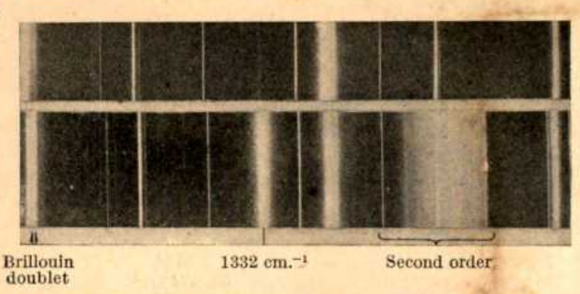

Fig. 1. ABOVE, FILTERED MERCURY SPECTRUM; BELOW, HEAVILY EXPOSED RAMAN SPECTRUM OF DIAMOND

The alkali halides are much less suitable than diamond as material for investigations in this field, for their vibration frequencies are much lower and are also broadened out by thermal agitation; by reason of the ionic nature of the crystal, they also appear much more feebly in the second-order Raman effect. Hence the difficulty of obtaining adequately exposed and well-resolved spectrograms free from the effects of false illumination is far greater. Nevertheless, the results I have obtained with rock-salt[3] are clear enough and should convince those with practical experience of spectroscopic research in this field. The experimental difficulties in recording satisfactory results are even greater in the case of potassium chloride and potassium bromide than in the case of rock-salt, since the vibration frequencies are still lower. A comparison of the spectrogram of potassium chloride I have obtained[4] with that reproduced in a recent note in *Nature*[5] indicates that

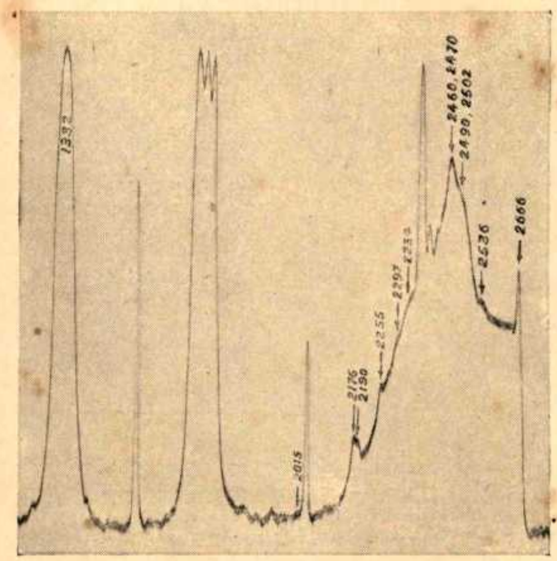

Fig. 2. PHOTOMICROMETRIC RECORD OF THE RAMAN SPECTRUM OF DIAMOND TAKEN WITH MEDIUM-SIZE SPECTROGRAPH

the latter has been vitiated by parasitic illumination in the spectrograph.

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May 19.

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[5] Gross, E., and Slehanov, A., *Nature*, 159, 474 (1947).

Adsorption Isotherm of a Photographic Emulsion for Uranyl and Lead Ions

RADIOACTIVE track count methods with photographic plates can be applied to the determination of nuclear reaction cross-sections, of nuclear particle fluxes, of decay constants and of small concentrations of certain elements[1]. The reactive nuclei can be introduced into the emulsion by the 'drop method', in which a drop of a suitable solution is spread on the surface of the emulsion, and left to penetrate into it, and to dry. This method uses the full quantity of the nuclei contained in the drop; however, the penetration into the emulsion is not uniform, so that an average track count must be derived from a survey of the whole area covered by the drop, or of a representative section of this area. In the alternative 'immersion method', the plate is left to imbibe the material from a solution in which the plate is totally immersed. Thus, the distribution of the dissolved substance over the emulsion must be uniform at least in the horizontal plane, but the fraction of the solute taken up by the emulsion depends on conditions and must be determined specially by conventional analytical or by radioactive methods. The uptake of uranium by Ilford Concentrated Half-Tone Plates and its dependence on time of immersion, conditions of rinsing after immersion, concentration of uranyl ion, pH and presence of other salts has been examined[1]. It seems desirable now to report the results of tests where the concentration was varied more widely, and where besides uranyl ions lead ions were employed.

The Ilford plates were handled as before[1], but the area of each field of view under the microscope was now only about 7×10^{-5} cm.^{2}. In Fig. 1 the uptake of uranium by the emulsion is plotted against time of immersion (in minutes) for four solutions of uranium in 5 per cent (by volume) acetic acid. The ordinates give the track counts (T) per field of view and 24 hours exposure, and are multiplied by factors of 1, 12, 40 and 60. The rate of uptake decreases rapidly with time, and the shape of the curves at all concentrations is similar. In Fig. 2 (based on more experiments than Fig. 1) the track count per 24 hours exposure following immersion of standard duration (1,000 min.) is shown (logarithmically, for clarity) as a function of the concentration c. In spite of the lack of saturation and the blocking of part of the volume of the emulsion by silver salt, the absolute values of the uptake exceed the values calculated from the volume of the (dry) emulsion; for example, the track counts of the $1{\cdot}2 \times 10^{-1}$ and the $5{\cdot}5 \times 10^{-5}$ M solutions would correspond to $1{\cdot}1 \times 10^{-10}$ and of $3{\cdot}5 \times 10^{-13}$ gram-atoms of uranium, respectively, in the cylindrical volume defined by one field of view (7×10^{-5} cm.^{2} area and the depth due to the thickness of the emulsion before fixing, namely, 2×10^{-3} cm.), and hence to concentrations in the emulsion of $0{\cdot}78$ and $2{\cdot}5 \times 10^{-3}$ M; these concentrations are larger than those in the solutions by factors of 6·5 and 45. The excess must be explained mainly through adsorption; the temporary expansion of the emulsion during impregnation through swelling is insufficient. Therefore, the uptake function of uranium (Fig. 2) can be described as an 'adsorption isotherm'. At saturation the adsorption isotherm will be of similar shape, as the ratio of the uptakes with different concentrations at 1,000 min. can scarcely differ from that at saturation (cf. Fig. 1). The uranium isotherm in Fig. 2 is well represented by a linear equation

$$\log T = \log A + f \log c,$$

with A as a numerical constant, and can be rewritten in the familiar form

$$T = Ac^f.$$

The exponent f has the value 0·80.

In tests with uranium the concentration cannot be decreased beyond certain limits if unreasonably long times of exposure are to be avoided. To cover a more extensive range of concentration some tests were carried out with the lead isotope thorium B, which can be diluted with inactive lead at will. In this way the radioactivity per unit volume of solution was kept constant, while the total concentration of

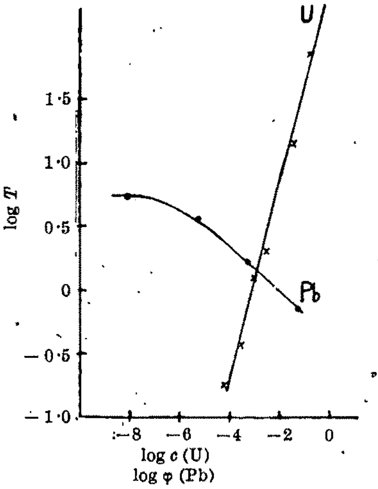

Fig. 2

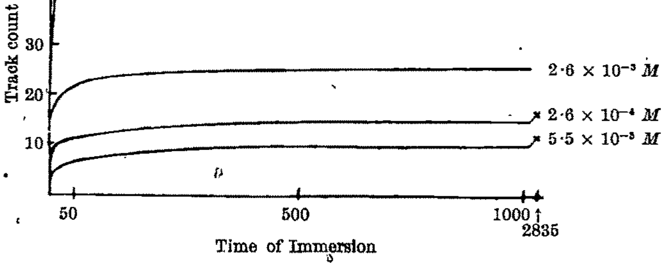

Fig. 1

lead was changed. Thorium B itself emits only β-rays, which are not registered by the plate, but every disintegration is followed quickly by α-decay of either thorium C or C′, so that the total track count (thorium C and C′ tracks combined) still gives the number of decayed thorium B nuclei. Four thorium B solutions (of the order of 10^{-2} micro-curies/c.c.) in 5 per cent acetic acid were used, in which the total concentrations of lead were made $5{\cdot}3 \times 10^{-2}$, $5{\cdot}3 \times 10^{-4}$, $5{\cdot}3 \times 10^{-6}$ and $6{\cdot}8 \times 10^{-9}$ molar. The time of immersion was 30 min. In Fig. 2 the logarithm of the track count is plotted against the logarithm of the concentration (φ) of inactive lead. Here, in the evaluation of the adsorption isotherm from the graph, the 'invisible' adsorption of inactive lead must be taken account of by replacing T and c by f_cT and φ.[1] The concentration c of the radio-lead remains constant. At the higher concentrations the results fit again a straight line. Hence

$$\log T = \log B + g \log \varphi,$$

that is,

$$(f_cT) = B'\varphi^{g+1} = B'\varphi^{f}.$$

In the linear portion the value of f is 0·83, but at concentrations below about 10^{-6} the uptake increases more rapidly with concentration.

It will be interesting to compare by this sensitive method the adsorbability in standard conditions of chemically different α-active isotopes down to very small concentrations. From a practical point of view the knowledge of the adsorption isotherms will assist in the assay by track count methods of traces of α-ray emitters.

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[1] Broda *J. Sci. Instr.*, 24, 136 (1947).

Mercury Tube Effect

By anodic polarization of the dropping mercury electrode, the drops have been made to form at the end of an apparent 'mercury tube or thread', namely, a semi-solid tube or thread of mercury, or a mercury compound, suspended from the capillary tube.

The dropping mercury electrode was polarized from the mains with the aid of a potential divider. A platinum electrode functioned as an anode, both for the dropping mercury electrode and in a supplementary circuit containing a 2-volt accumulator for the cathodic polarization of a layer of mercury at the bottom of the cell (used in the purification of the solution by pre-polarization). The dropping mercury electrode was first polarized cathodically at a current-strength of 10^{-1} amp. At this current bubbles were generated at the end of the tip and dropping ceased. The applied potential was now decreased to zero, thus connecting the dropping mercury electrode with the platinum anode and anodically polarizing it with respect to the cathodic mercury pool at the bottom of the cell. A few seconds after the commencement of anodic polarization, darkened drops appeared, which, upon falling from the capillary, left behind them a black tube. After the formation of the tube, the drops grew at its end and fell therefrom, largely as if from the capillary. In some experiments, after an indefinite time from the commencement of formation of the tube, a sudden extension in its length took place; this seemed to occur when the drop size was at its maximum. The potential of the dropping mercury electrode was about + 1·7 volts on the hydrogen scale at the commencement of the phenomenon, and seemed generally to fall to a potential between about + 0·8 and + 1·3 volts when the phenomenon ceased.

The black thread was collected in a cup operated from outside the cell. The collected substance appeared to decompose rapidly to mercury when removed from the solution, thus making its analysis difficult.

It seems probable that the anodic evolution of chlorine at the electrode in the above experiment forms a thin film of a chloride of mercury and that it is an elongated skin of this which forms the tube. It is possible that the sudden increase in length of the tube sometimes observed is due to the completion of a layer of a different chloride formed during the continued anodic polarization.

An investigation of the phenomenon is in progress.

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Spiral Cracks in Glass Tubing

To the examples cited by Dr. J. J. Hopfield and Messrs. B. N. Clack and N. L. Harris on this subject,[1] I should like to add a further rather unusual example. This was in $X8$ soda-glass tubing of 6–7 mm. diameter and 0·15–0·25 mm. wall-thickness. Large quantities of this tubing were being handled, and frequently, when it was being cut into lengths, a spiral or rather helical crack would fly along the piece. The cracks were of 5–7 mm. pitch, and produced springy lengths of up to 12 in.

With such a thin wall the strain 'through the wall', which caused such cracks as those previously cited, would scarcely at first sight be expected. However, the tubing was being produced by machine-drawing at a very high rate, some 1,000 ft. per minute, so that the rush through the air and the resulting rapid cooling of the outer skin, while the inner was kept hot by the hot air-blast through the mandrel, could very well have produced this strain. In the very thin section this strain was naturally difficult to detect.

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[1] *Nature*, 158, 582 (1946); 159, 541 (1947).

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

THE manifold demands made by a live industry on its research association are well illustrated by some of the current activities of the British Iron and Steel Research Association. Co-operative research lends itself readily to organised investigation into the background problems of industrial processes. Sometimes these are indicated by the failure of an unproved technique; sometimes by new demands on the part of the user which call for extension of knowledge and technique on the part of the supplying industry; but most often the process is dictated by the natural desire of the industry concerned to improve its processes, qualities and general economy.

An example of investigations stimulated by the failure of a technique insufficiently understood is the work which has been done on brittle fracture in mild steel plates. The welding in certain ships made in foreign countries during the War failed, and representatives of all British organisations interested—governmental and Service departments, other research associations, the universities, Lloyd's and numerous industrial laboratories—carried out various investigations culminating in a conference in October 1945. As a result of intensive discussion under the chairmanship of Dr. (now Sir Andrew) McCance, who is chairman of the council of the British Iron and Steel Research Association, the lines of research necessary for ascertaining the cause and cure of the phenomenon of brittle fracture were indicated.

Subsequent researches at the works of Colvilles Ltd., and at the University of Cambridge, established that brittle fracture was related to manganese content, plate thickness and the rate of cooling, the effect of the first factor being by far the greatest. Further work at Colvilles on small, closely controlled casts of steel made by the high-frequency process has now established that for a given tensile strength an increase in the manganese – carbon ratio of mild steel has the desired effect of lowering the temperature range below which one must go before brittle fracture may take place. This effect is related to the fact that the increased ratio also tends to give a fine-grain steel. The latest work on this subject is able to conclude with a practical recommendation that for shipbuilding steels the manganese – carbon ratio should not be less than 3·0.

The results to date of this extensive series of experiments have been distributed to the members of the Association and participants in the original conference, and are shortly to be made available to a wider public through the technical press.

Another project also bears on embrittlement, but in this case at high temperatures. The brittle constituent (sigma phase) of the iron – chromium and the iron–chromium–nickel systems is being studied at the National Physical Laboratory for the Association, as the appearance of this constituent during service at elevated temperatures can cause serious embrittlement in certain commercial alloys. Limits in composition to avoid the appearance of the sigma phase are now being defined for pure ternary alloys, and eventually the effect of other elements upon the systems will be investigated. A related and rather more extensive research deals with the influence of alloying elements on the properties of ferrite.

These latter projects may be taken as examples of investigations with the object of meeting new demands, in this case made by the designers of gas turbines and other high-duty engines. The successes met with by the works laboratories, working in competition, are well known, and may be said to be approaching their limits within the bounds of the available 'background' knowledge. It is the natural task of the research association to organise the pooling of information to the necessary extent, and to widen our background knowledge, thus enabling the industrial laboratories to proceed once more in healthy rivalry. This is a continuing process, which an alert industry will demand of its research association without intermission.

The great bulk of the work of the British Iron and Steel Research Association, however, originates from the discussions of the voluntary panels and committees which supervise and canalize the Association's activities. These committees are widely drawn from the iron and steel industry, the universities of Great Britain, Government research laboratories, steel users, etc. They are kept small, the total membership numbering about 450 for nearly sixty committees. The Association's work is organised in six divisions, corresponding to the main divisions in the industry, each being controlled on a largely decentralized basis by a panel. There are also three, so to speak, 'horizontal' departments (physics, chemistry and engineering) which carry out more fundamental work and work common to a number of divisions, and incidentally play a useful part in maintaining liaison between the six divisions.

Some three hundred projects are in hand, covering the industry's production cycle from the blast furnace and its raw materials to the rolling mill, draw-bench and final application. These projects range from the severely practical to the 'purely' theoretical.

The modern blast furnace is highly efficient from a thermal point of view. Improvement is sought, however, in output, smooth working, high-grade production, requirements of special coke and in general operational economy. A considerable volume of work goes on in attempts to determine the best conditions and proportions of the constituents of the burden, the best methods of distribution and the extent of heat and gas penetration into various types and sizes of ore. Consideration is also being given to the use of gas turbines for blowing. The Association has an experimental blast furnace with a 1 ft. 9 in. hearth at Stoke-on-Trent where much of this work is carried out. This 'baby' is believed to be the smallest working blast furnace in existence.

At Stoke-on-Trent the Association has in addition a model open-hearth furnace, which for the last two years has afforded information of great importance on the design and operation of such furnaces. Also at the steel-making stage the factors affecting sulphur removal are being studied both in the plant and in the laboratory. Most of the latter work is done at the universities. The subjects of instrumentation and heat measurement receive their share of attention, and the new problems raised in the extensive programme of converting open-hearth furnaces to oil firing lend particular importance to these investigations. The Physics Department has constructed a black-body furnace with a 3-in. aperture for calibrating pyrometers up to 1,700° C., and is also investigating problems in connexion with quick immersion thermocouples.

It is part of the task of the Chemistry Department to work in close collaboration with the British Refractories Research Association, and one of the big problems in this field is at present the development of the all-basic open-hearth furnace. This should have many advantages over the normal type with a silica roof, and its higher operating temperature should result in increased output.

In the field of steel castings, a thorough investigation is being made into foundry moulding materials and the fundamental mechanism whereby they are bonded together. The allied problems of hot tearing and the rate and direction of heat abstraction on solidification are being examined, as also are methods of controlling the melting process by spectroscopic inspection of the flame of Tropenas converters during steel-melting.

Work going forward nearer the finishing end of the industry includes research on coating, rolling and drawing. At the Association's new laboratories in South Wales (see *Nature*, July 19, p. 100), work goes on concerned with the distribution, thickness and porosity of tin, zinc and non-metallic coatings, and with further projects on the geometrical characteristics of metal surfaces.

In the investigations into drawing problems, the Physics Department has assisted in devising an instrument for measuring the tension in wire as it is drawn, the variations in oscillation under varying tensions being used for this purpose. Theoretical and practical work on plastic deformation in rolling goes forward at the Universities of Cambridge and Sheffield.

The engineering problems that face the iron and steel industry are sometimes insufficiently regarded as being suitable objects of scientific approach. Here the Association's Plant Engineering Division has a wide field, and has done much useful work in organising conferences and other means of exchanging knowledge—a function of immediate importance in the industry's modernization plans. This Division also methodically studies steel-works transport, design and operation problems, and is responsible for a wide range of research on fuel problems.

This very brief summary suffices to show the immensely wide field an industrial research association has to cover. The work ranges from the most 'purely' theoretical study of the thermodynamic and chemical aspects of the steel-making process, to the most severely practical investigation into engineering problems. All this is comprehended in the mutual aim of science and industry to ensure that the methods and discoveries of the one shall be with the least delay at the service of the other.

BOTANY OF THE WILD AND CULTIVATED RICES

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ALTHOUGH much work has been done on the widely cultivated species of rice (*Oryza sativa* Linn.) for its improvement as an agricultural crop, it must be admitted that our knowledge of its morphology and taxonomy and its relationship to other wild species of the genus is comparatively meagre. The term 'wild rice' as employed here is used to indicate all other species which conform by their technical characters to the generic definition of *Oryza*, and which grow spontaneously in a wild state. The two cultivated species are the well-known *Oryza sativa* Linn. and the less known *Oryza glaberrima* Steud. (cultivated in west tropical Africa). In tropical countries where these species are extensively cultivated, it is unfortunate that a comprehensive account of the rice plant with a proper interpretation of all the structures, its evolution and domestication by man is not generally given in text-books on botany and tropical agriculture. This omission makes its study uninteresting and often vague. The aim of this note is to put together some of these much-needed data with a suitable list for further reference.

Domestication of 'Wild Rice' by Man

The history of cultivated rice goes so far back into the distant past that it could be associated with the early history of man. It has been said that man has passed through three successive stages of civilization, that is, the hunting, pastoral, and agricultural. In the early stage men hunted in packs the wild animals of the grassland. The women also hunted with the men and equally shared the products of the chase. The cares of maternity and increased attachment to their homes often made it necessary for the women to drop out from the band for a time. Gradually women found it necessary to supplement their diet with nuts, berries and grains of grasses at times when the food supplies brought by their men-folk ran out. Homes were established near the seashore and banks of lakes and rivers. Fishes and molluscs were also gathered from these sources to supplement the food. Domestication of cattle began at this stage of pastoral life. The idea of growing grains of wild grasses by actual cultivation of land came later, and the exact circumstances are not known but are subject to various speculations.

Recent discoveries in India at Mohenjo-daro in Sind and at Harappa in the Punjab have shown that civilization entered the country as early as 3000–2500 B.C. It appears that the people who came to the Indus Valley at that time from the west had a knowledge of wheat cultivation and they readily adopted the wild rice which they found in that part of India. There is also reason for believing that the people of Mohenjo-daro had trade relations with the Sumerian cities of Mesopotamia, and both wheat and rice might have constituted the articles for trade. Between 400–300 B.C. rice was cultivated beyond the western limits of India and later it was grown in Babylonia, Bacterina and lower Syria. During the early period of the Christian era cultivation was started in Persia and Egypt. In China and Indo-China rice was in cultivation for a long time and no definite account is available how these countries received the art of rice cultivation from the Indus Valley. A possible suggestion is by way of the Hindu Kush, Tibet and Mongolia. The cultivation has spread to Malaysia, Africa and America in recent years. Knowledge of rice cultivation came to south-eastern Europe through the Arabs, who also introduced its cultivation in Spain after their conquest of that country.

The wild rice of India, which may be regarded as the ancestor of the cultivated rice, is found throughout India, Burma and Malaysia. It resembles the ordinary cultivated rice very much but has deciduous spikelets, 3–10 cm. long awns, and a dark red spot between the apex of the *lemma* and the awn. Having taken this plant into domestication, early man, consciously or unconsciously, effected a general trend of improvement by selecting those plants which possessed certain desirable and stable characteristics. These might have been: (1) tufted growth and production of tillers, (2) a height of 3–4 ft., (3) suitability of living in still and shallow water, (4) production at the end of about six months of starchy grains which are not shed, and (5) when the husked grains are boiled they give a pleasant appearance and do not adhere to each other. From this theoretical line, it must be admitted that variations due to mutation and hybridization must have taken place which have given rise to the several hundreds of forms and varieties. The main important change, introduced by domestication, to the wild rice, is the loss of its power to shed the mature spikelets. The power to shed the mature grains is an essential character connected with the dispersal of the seed and ensuring the continuity of the species in all wild plants. This loss of power to shed grains has indeed been a gain on the part of the cultivator; he can now get all the spikelets for the use of mankind from his crop without the fear of losing a large quantity on the field.

Botanists like Chevalier[1] and Backer[2] have considered that the name of this wild rice should be *Oryza fatua* Koen. This name was also followed by Burkill[3] in his discussion of the origin of the cultivated rice. Unfortunately, for technical reasons this name could not be accepted, as this was not validly published with a suitable specific description (*Mem. Acad. Sc. Petersb.*, Ser. 6, 5, pt. 2, 177; 1840). The same plant was described by Prain[4] under the name *Oryza sativa* Linn. var. *fatua* Prain, and this name may be provisionally retained to designate the wild rice of south-east Asia. It is preferable that the wild rice should be separated specifically from the cultivated species of *O. sativa* Linn., since this will be more convenient from the point of view of agricultural workers and other practical considerations. The varietal name given by Prain has to be given up when the specific name of this wild rice is determined by a monographer of the genus. The choice will probably depend on one of the three names *O. montana* Lour. (1790), *O. aristata* Blanco (1837), and *O. rufipogon* Griffith (1851). The type sheets of none of these species are available to me, and so I have left the point undecided and provisionally accepted Prain's varietal name. A good description of this wild rice is given by Bor[17], Backer[2] (under *O. fatua* Koen.) and Watt[18] (under *O. sativa* Linn. var. *bengalensis* Watt).

The cultivated rice *O. sativa* Linn. embraces wide variations in forms, and in all probability it is a composite species of polyphyletic origin. Griffith says, "It has always appeared to me that the union of all the different kinds of rice into one *O. sativa* Linn. was arbitrary. Roschevicz[5] says, "Our cultivated rice is of polyphyletic origin and that its different groups and varieties may have arisen from different species of wild rice belonging to the section *Sativa* Roschev., or from hybrids between the wild rices of this section and cultivated ones". Roschevicz also admits that *O. sativa* Linn. represents in all probability a complex of small independent species.

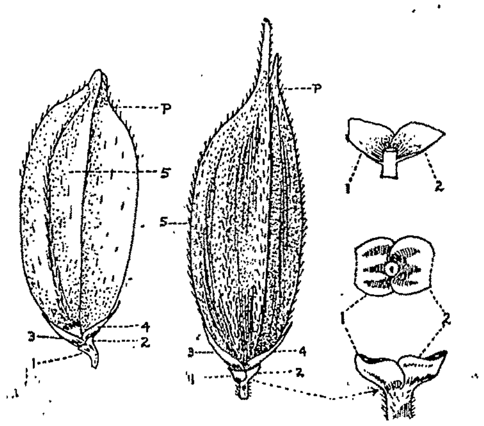
In Africa, some varieties of a cultivated rice approach *O. breviligulata* A. Chev. et Roehr. by the characters of ligule, the thickness of panicle, the strong thick awn, and Chevalier[1] rightly thinks that this wild species should be regarded as the ancestor of *O. glaberrima* Steud. which is largely cultivated in west tropical Africa along with *O. sativa* Linn.

The Rice Spikelet

The development of a large number of spikelets in the panicle is no doubt the primary cause of the reduction of some of the floral and extra-floral parts which has made the morphology of the rice spikelet a subject of special interest to botanists. The commonly known interpretation which is also found in some of the text-books is that the rice spikelet has four scales, of which the lower two are considered as non-flowering and the third large boat-shaped structure as the flowering scale (or lemma). In the axil of the lemma and between it and a similar structure, the palea, the flower is borne. There are two other very minute and extremely reduced scales at the tip of the pedicel which have been treated by many botanists as mere outgrowths. But the fact that these are constantly present and often distinct and better developed in some species shows that these are significant structures and have to be interpreted.

In 1900, Stapf[6] suggested that the rice spikelet theoretically or normally consists of six scales, of which the two lowest are very minute and more or less confluent with the tip of the pedicel and rarely discernible except with the use of a high-powered lens. The spikelet is therefore only apparently articulate with the pedicel, the real articulation being above these two rudimentary glumes. The two following structures, also empty, are usually small and one or rarely both are sometimes suppressed. The next one is the flowering scale (fertile lemma) and the uppermost the palea. The palea is very anomalous, being three-nerved and as coriaceous as the fertile lemma. In 1908, Cooke[7] arrived at the same interpretation and described the spikelet of the genus *Oryza* as having six scale-like structures. In his description of *O. coarctata* Roxb. he referred to the lowest pair of these scales as "two opposite minute appressed rounded or truncate thick scales, one attached lower than the other". Later Graham[8] made a particular study of the upper end of the pedicel of rice spikelet, and concluded that the enlargement at the tip is generally annular and in many varieties this structure becomes scale-like. Both Cooke and Graham admitted the presence of two scaly structures at the tip of the pedicel. These scales, although somewhat reduced in *O. sativa* Linn., are better developed in *O. ridleyi* Hook.f., while they are relatively large, clearly defined and well developed in *O. australiensis* Domin.

Other supporters of Stapf's view are Arber[9], Hubbard[10] and Michaud[11]. Arber made serial sections through a young rice spikelet which convinced her that the apical outgrowth at the tip of the pedicel really represented two outer glumes in an extremely reduced form. Hubbard, in his discussion, confirmed Stapf's interpretation, and also showed with a very ably executed drawing that this particular pair of glumes was exceptionally well developed as two distinct semi-oblate structures. Lastly, Michaud's discovery of abnormal florets in the axils of the pair of scales commonly considered as non-flowering indicates that these should be considered as flowering scales (or lemmas), although they are usually sterile. This naturally suggests that the spikelet of rice is theoretically three-flowered and consists of six scales and one flower as stated by Stapf. This view may be regarded as the best interpretation of the rice spikelet and is shown in Fig. 1. The lowest pair of scales should be considered as the glumes (true), the next pair of scales as sterile lemmas and lastly the fertile lemma enclosing a flower between it and the usual coriaceous palea.



O. sativa Linn. *O. australiensis* Domin
1, 2, glumes ; 3, 4, sterile lemmas ; 5, fertile lemma ; *P*, palea.

Fig. 1

Stapf arrived at his interpretation of the rice spikelet only after careful examination of considerable herbarium and fresh material. His supporters, too, examined the spikelet from different points of view and came to the same conclusion. The present writer has also examined all the species of *Oryza* and agrees with Stapf and others. But Backer[3] has recently opposed this interpretation, and pleaded for a reversion to the older theory of regarding the lower pair of scales as mere cupular outgrowths of the pedicel tip and the sterile lemmas as the glumes. It is not known whether he examined the materials of species like *O. australiensis* Domin and *O. ridleyi* Hook.f. or whether he consulted the publications of Arber, Hubbard and Michaud (loc. cit.). In any event, he did not say so in his discussion. Backer has also erred in describing Stapf's view as merely theoretical, whereas his own might equally well be so described, since he compares the pedicel tip of *Oryza* with true examples of cupular structures from *Asthenochloa*, a genus belonging to a very different and distinct tribe of grasses. An examination of the spikelet of *O. australiensis* Domin would show quite clearly that these two scales are placed one *above* the other and not in the form of a cup, as is commonly imagined, and as is found in *Asthenochloa*.

Peterson[12] and Parodi[13] independently advanced a somewhat different view on the structure of the rice spikelet. Their views involve certain bold assumptions with which I cannot agree. According to them the rice spikelet essentially represents the union of two florets, in which the paleas of both and the pistil of one have disappeared. The two large scales enclosing the flower are then considered as two fertile lemmas. If we accept their view that the so-called palea is really a lemma of the theoretical second flower, then in a serial section this would appear after the point of insertion of the first flower is well passed. But Rossberg[14] has shown that this is not the case and that the so-called palea appears to originate beneath the first flower. This reduces the second fertile lemma of Peterson and Parodi to the status of a palea. The present writer has no doubt that this structure is truly a palea, as in a mature caryopsis. the hilum points towards it. Incidentally, Rossberg has also tried to explain the unusual three-nerved palea of rice. According to him the palea evolves in a grass spikelet by the intergrowth of two originally separate leaves or leaf-primordia. These primordia have one or two nerves each and we get a two- or four-nerved palea by their lateral fusion. It has been reasonably suggested that the three-nerved palea is derived from a four-nerved one by the union or coalition of the two inner nerves or by the replacement of the inner two by a single nerve.

The Genus *Oryza*

The genus *Oryza* belongs to the Oryzeæ tribe of grasses. This tribe is characterized in having plants which are usually hygrophilous or aquatic and having small similar or dissimilar one–three-flowered spikelets, reduced scale-like sterile lemmas and minute glumes below, disarticulating rachilla, three–nine-nerved lemma and palea and usually six (rarely three, two or one) stamens. In the old world, genera like *Leersia*, *Potamophila*, *Oryza* and *Hygroryza* are well developed, while in America these are counterbalanced by the development of genera like *Luziola*, *Zizaniopsis* and *Hydrochloa*. The genus *Lygeum*, which was originally considered to belong to the tribe Oryzeæ, has now been separated out on account of its characteristic chromosomes. Genera like *Anomochloa* and *Reynaudia* are also now excluded from this tribe for other obvious reasons. The tribe Oryzeæ is subdivided into two groups, Oryzineæ and Zizaninæ, on the basis of hermaphrodite and unisexual flowers. A general account of these genera with suitable keys has been given by Prodoehl[15] and Bews[16]. The genus *Oryza* is undoubtedly the most important in the tribe and should be re-defined along the lines of Stapf's view discussed above. It consists of twenty-three species distributed in the warmer parts of Asia, Africa, Australia and America. Fig. 2 shows the general distribution of the species.

The species which I accept as good species and are referred to in the map are as follows: 1, *O. alta* Swallen; 2, *O. australiensis* Domin; 3, *O. brachyantha* A. Cheval. et Roehr.; 4, *O. breviligulata* A. Cheval. et Roehr.; 5, *O. coarctata* Roxb.; 6, *O. eichingeri* Peter; 7, *O. glaberrima* Steud.; 8, *O. grandiglumis* (Doell) Prodoehl; 9, *O. granulata* Nees et Arn. ex Hook.f.; 10, *O. latifolia* Desv.; 11, *O. meyeriana* (Zoll. et Mor.) Baill.; 12, *O. minuta* Presl; 13, *O. officinalis* Wall. ex Watt; 14, *O. perennis* Moench; 15, *O.*

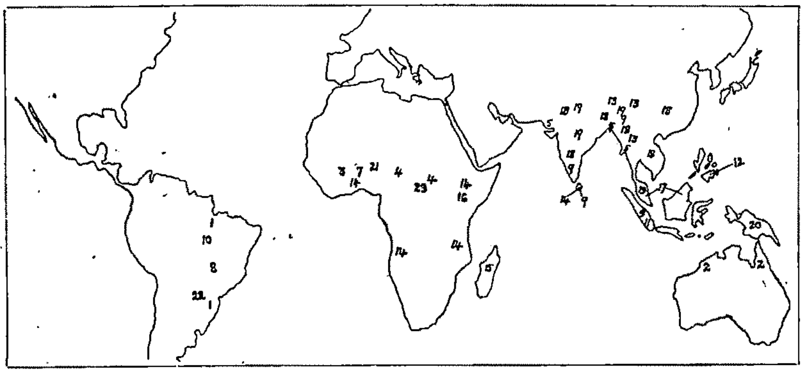


Fig. 2. DISTRIBUTION OF WILD AND CULTIVATED RICES

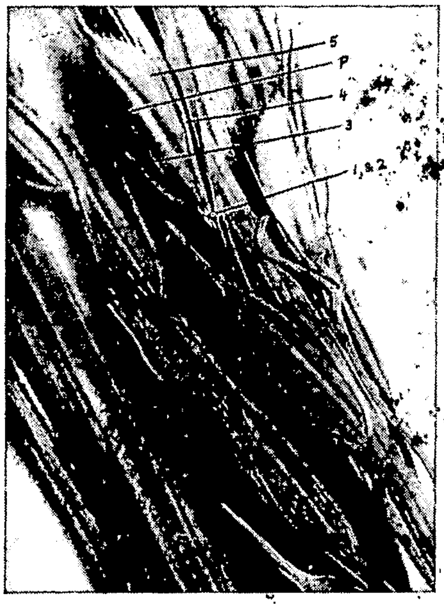


Fig. 3
O. ridleyi Hook.f.

perrieri A. Camus; 16, *O. punctata* Kotschy; 17, *O. ridleyi* Hook.f. (Fig. 3); 18, *O. sativa* Linn.; 19, *O. sativa* Linn. var. *fatua* Prain; 20, *O. schlechteri* Pilger; 21, *O. stapfii* Roschev.; 22, *O. subulata* Nees; 23, *O. tisseranti* A. Cheval.

The cultivated area of *O. sativa* Linn. is not shown in the map. It is cultivated throughout south-east Asia, China, New Guinea, Persia, Egypt, east, central, and west tropical Africa, Italy, Spain, and Central and South America.

A fuller account, with a key to the species and their synonymy, will be published elsewhere.

I am indebted to Dr. S. D. Chaudhury, Economic Botanist, Assam, for directing my attention to the subject, and also to my colleague, Mr. C. E. Hubbard, for valuable help in the preparation of this article.

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ANIMAL DISEASES AND HUMAN WELFARE

IN March, 1946, the Section of Biology of the New York Academy of Sciences held a conference on the "Relation of Diseases of the Lower Animals to Human Welfare", and the nine papers read before this conference have been published in the *Annals* of the Academy (48, Art. 6, pp. 351–576; 1947). These papers, each of which is contributed by an expert, deal with rabies, equine encephalomyelitis, psittacosis and diseases related to it, brucellosis, plague, tuberculosis, anthrax, swine erysipelas and various animal parasites transmissible to man. In his introductory address, W. A. Hagan points out that the authors of the various papers consider primarily diseases of animals which are more or less directly transmissible to man, but that these diseases also affect the welfare of mankind by their economic effects. Obviously, for example, they affect our food supplies and, in addition, many people depend for their livelihood upon the rearing of farm animals.

The statistics given by Hagan of the losses inflicted by disease upon farm animals in the United States certainly bring home to us, especially just now when world food supplies are so difficult, the very great importance of the study of animal diseases. Nearly half the pigs born in the United States die before they reach marketable age. To this loss must be added the loss of the grain fed to them and also the increased cost of the products derived from the pigs which do survive. About a quarter of the 'adult chickens' die from disease each year in the United States, and one cow out of every four or five contracts inflammation of the udder (mastitis), with a consequent serious reduction of the milk supply and an increase in its price. The total losses from animal diseases in the United States are, Mr. Hagan thinks, probably smaller than they are in any other major country. Rightly he calculates not only the losses due to actual deaths, which represent only a fraction of the total loss, but also the effects of various kinds of parasitic animals which reduce the vitality of farm stock and render them more liable to diseases caused by other agents. As Mr. Hagan puts it, losses due to morbidity are much greater than those due to mortality.

A table of losses in 1942 due to various causes, which was compiled by the United States Bureau of Animal Industry, places the total losses due to parasitic animals alone at 290 million dollars, which is 69 per cent of the total animal loss of 418 million dollars. Chronic infectious diseases accounted for a loss of 70 million dollars. Acute fatal diseases, on the other hand, caused only 15 per cent of the total loss, and more than three quarters of this amount was due to a single disease—hog cholera. These figures, startling as they are, are considered by Mr. Hagan to be far too low. He would place the total annual loss at more than a thousand million dollars.

There is, however, a brighter side to this grave picture. The table given also shows that some of the great scourges of farm stock in other countries have been eliminated, or nearly eliminated, from the United States. Tuberculosis of cattle, for example, which is still a serious scourge of Britain and other countries, has been almost eradicated from the United States; and rinderpest, foot-and-mouth disease, bovine piroplasmosis and contagious pleuropneumonia have also been wiped out.

These are great achievements. Their value in terms of the relief of animal suffering is incalculable. Their economic value to man can be gauged by reference to the figures given above. Nor must we forget that many of the major diseases of farm stock are communicable to man, tuberculosis being in the forefront of these. It would seem, indeed, that, if the achievements recorded in this series of papers could be repeated in all the great food-producing countries of the world, the present urgent problem of the world's food-supplies would either disappear or would be very much less difficult to solve. How much is being done in various countries is evident in the articles which appear in this important publication. Unhappily evident also, however, is the gravity of the menace of the diseases which still remain to be overcome. The conquest of these may take time; but it cannot long resist the kind of spirit and effort which veterinarians all over the world, and the medical men who work with them, are contributing to the international service of mankind.

G. Lapage

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Speech Therapist—The County Medical Officer, County Hall, Hertford (August 23).

University Fellowship in Engineering, University Post-graduate Studentships (*a*) Kitchener (Engineering), (*b*) David Rew (Electrical Engineering), (*c*) Joseph and Lucy Chadwick (Engineering), —The Registrar, The University, Liverpool (August 23).

Assistant Professor of Mining, and an Assistant Professor of Geology, at the Faculty of Engineering, Fouad I University, Giza, Egypt—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (August 31).

Senior Lectureship in Accounting at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 31).

Professor of Oceanography (biological, physical, or both) in Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (August 31).

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Readership in Colonial Administration tenable at the London School of Economics—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 4).

Assistant Lecturer in Applied Mathematics—The Registrar, University College, Hull (September 6).

Technician in the Anatomy Department—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1 (September 6).

Lecturer (Grade I) in the Physiological Department (Lecturer in Histology)—The Secretary, The University, Edmund Street, Birmingham 3 (September 6).

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Senior Principal Scientific Officer or Principal Scientific Officer in the Armament Research Department of the Ministry of Supply in London—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1961 (September 18).

Lecturer in Anatomy, preferably with some experience in Histology—The Secretary, The University, Aberdeen (September 18).

Vice-Chancellor, and a Senior Lecturer in Geology, at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 30).

Professor of Celtic Languages and Literature—The Secretary, Queen's University, Belfast (September 30).

Senior Plant Breeder and a Senior Plant Physiologist under a Cocoa Research Scheme for the West Indies—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (October 1).

Professorship of Sociology at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 14).

Lecturers (3) in Physics in the University of Queensland—The Agent-General for Queensland, 409 Strand, London, W.C.2, or The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Brisbane, October 18).

Alan Johnston, Lawrence and Moseley Research Fellowship into the problems of human and animal health and diseases and the biological field related thereto—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (November 1).

Foulerton Research Fellowship in Medicine—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (November 1).

Demonstrator in the Department of Physiology—The Registrar, University College, Nottingham.

Senior Laboratory Technician (with extensive experience in pathology, bacteriology and haematology)—The Dean, Ophthalmic Institute, Moorfields Eye Hospital, City Road, London, E.C.1.

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Assistant Lecturer in Agricultural Chemistry (Insecticides and Fungicides)—The Registrar, The University, Reading.

Assistant Lecturer in the Department of Engineering—The Registrar, University College, Singleton Park, Swansea.

Medical Biochemist (male or female)—The General Superintendent and Secretary, Salford Royal Hospital, Salford.

Scientific Assistant—The Director, Imperial Bureau of Dairy Science, Shinfield, Reading, Berks.

Lecturer (*a*) in Physics, and (*b*) in Biology, at the Queen Aliya Institute—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

Senior Physics Technician at the biological research unit being established at the Atomic Energy Research Establishment, Harwell—The Medical Director, Medical Research Council Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

Assistant Masters (*a*) in General Science and Chemistry, and (*b*) in History and Geography, at the King Faisal College—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

Research Assistants (2) to investigate insect and nematode pests of sugar beet—The Secretary, School of Agriculture, Cambridge.

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Secretary to the University—The Secretary, The University, Edinburgh.

Professor of Physics, a Professor of Mechanical Engineering, a Professor of Electrical Engineering, a Professor of Civil Engineering, a Lecturer in Physics, a Lecturer in Mechanical Engineering, a Lecturer in Mathematics (Descriptive Geometry), a Lecturer in Civil Engineering, a Lecturer in Electrical Engineering, and a Lecturer in Architecture, at the Engineering College, Baghdad—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

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RECRUITMENT AND EFFICIENCY IN THE CIVIL SERVICE

THE Prime Minister, in a statement on the Civil Service on June 24 in the House of Commons, paid a well-deserved tribute to the Service as a whole. This praise was timely, for much current criticism of the Civil Service has been both unfounded and unfair, and has been directed against officials when it should rightly have been directed against those responsible for the policies which the Civil Service is called upon to execute. Mr. Attlee was right to repudiate the fashion of slighting the Civil Service, and to point out that we shall neither get the best out of the Service nor be able to recruit to it the energetic and able young men and women it needs if the practice of depreciating its work continues.

Much less satisfactory, however, was that part of the statement dealing with the future plans for reducing the size of the Civil Service. The Prime Minister gave four main reasons for not expecting large reductions at the present time. There is still much work to be done arising out of war conditions, such as work on war damage and re-settlement. While shortages compel the retention of rationing and other controls, a considerable staff is required for such work, amounting to 44,000 of the Civil servants employed on temporary work. Then, measures approved by the House, such as those dealing with the social services, education and civil aviation, cannot be implemented without such staff; and finally, there are the large staffs who, without substantially changing their duties, will shortly be transferred from outside the Civil Service to the Ministries of Agriculture and of National Insurance.

Up to a point, these are valid reasons; but they make it the more imperative that there should be a radical reconsideration of the systems of controls and of the internal organisation of the Civil Service from the point of view of the most efficient use of available man-power. Apart from the efficiency of a particular system of control, there may come a point when retention of the control does not justify the expenditure of man-power on its continuance. The same man-power expended on productive purposes might, even where an imported commodity is concerned, more than offset the drawback of increased import to supply a reasonable demand and prevent scarcity. If it is to be accepted, as the Prime Minister said, that the size of the Civil Service depends mainly on the jobs it is given to do, it is an over-riding imperative in the present man-power situation that the Government should see that these jobs are held in such constant review that all non-essentials are eliminated as conditions change. It is equally important in such a review that the effect on the national efficiency and economy as a whole should be kept in mind. The Prime Minister's statement referred to the 258,000 out of a total of 722,000 non-industrial Civil servants who are in the Post Office. The repeated criticism of the recent curtailment of postal services suggests that the cutting down of staff has been dictated more by near-sighted economy than by a broad view of the importance and implications of an essential service. It is not too much to say that the restrictions have more than offset many of the improvements in speed of communication which applied science has brought, and given us in Britain to-day a postal service well below the standard of that of the nineties of last century.

Both these factors bear on the question of recruitment, to which the Prime Minister devoted the latter half of his statement. Unless a high standard of public service is maintained and administrative review continually eliminates redundant posts, the mere cessation of the attacks to which the Prime Minister referred will be of little avail. Recruits of the high standard required will neither be attracted to the Service nor remain with it unless they find in their work the satisfaction of genuine public service.

That was a point effectively made by Sir Oliver Franks in his lectures on "Central Planning and Control in War and Peace". The satisfaction of doing a job related in a direct and intelligible way to the national need should be an incentive which counts for more than a little in helping the Civil Service to recruit men and women of the type it needs. So far as recruitment to the Service is concerned, however, Sir Oliver did not discuss the aggregate size of the Service; he limited himself to insisting on the need for providing the Civil Service with more experts possessing both specialized training in the techniques of forecasting and estimating and knowledge of the world, and on the urgent need of relieving the chronic overwork of senior Civil servants, particularly those in departments dealing with economic affairs.

Sir Oliver made two suggestions here: first, the use of advisory groups of men drawn largely from industry and commerce, and secondly, the creation of additional posts of 'second secretary', free from departmental duties. From the point of view of organisation, it might well be argued that the latter suggestion does not go far enough, and that it would be sounder practice to separate the administrative and the planning or advisory responsibilities of the 'permanent secretaries' so that no one individual carries the responsibility for running a large department and for planning and advising the Minister on policy. The essence of both suggestions, however, is not merely to provide the senior Civil servant with that degree of leisure upon which sound judgment in planning depends, but still more the association with the Civil Service of men with a wider outlook, experience and training than at present.

This is one of the main points made in a recent broadsheet entitled "Recruiting Civil Servants" issued by Political and Economic Planning (No. 266. May 23, 1947). The main purpose of this broadsheet, which is a preliminary study prepared by the P.E.P. Manpower Group, is to examine the extent to which the principles and methods of recruitment and training affect the way in which jobs are done. It is pointed out that since the jobs entrusted to Civil servants are the result of policy decisions taken at the political level, it is only in the way they do the jobs given them that Civil servants can legitimately be criticized. The broadsheet considers in turn the main classes of the Home Civil Service and then the Foreign and Colonial Services, but the administrative class is discussed at greatest length.

Hitherto, the administrative class has probably been weakest on questions of organisation and management, as was indicated in the Sixteenth Report from the Select Committee on National Expenditure for the Session 1941–42; and the report of the Assheton Committee on the Training of Civil Servants has since formed the basis for a serious effort to give Civil servants a systematized professional training. A director of training and education was appointed at the Treasury in January 1945, with responsibility, in association with the joint Whitley Council on Training, for exercising general control and guidance over training policy throughout the Service and for conducting training courses where this can be done better centrally than in each department. All the larger departments have now organised schemes of training, giving particular attention to making proper arrangements for receiving the new entrant and helping him to understand the enormous organisation he has joined.

The administrative class needs, however, a wider variety of talent than it has had in the past. The kind of men likely to improve defects in the organisation of the Service are those who would make good business executives: men of good intelligence and with outstanding qualities of personality—imagination, drive and balanced judgment. The P.E.P. Broadsheet urges that a proportion of the new entrants should be chosen primarily on these grounds. It is intended to restore the normal competitions not later than 1949. The majority of the entrants will then be selected by the pre-war method; but a proportion will be taken from people with at least a good second-class honours degree, who will be judged on their previous careers, coupled with an interview and a few written tests of a general character. This is a major change in the principle and method of recruitment to the administrative class, and if it is to be successful it is vital that the right qualities should be sought and that they should be satisfactorily assessed. Methods normally used by interview boards, and consequently the decisions reached, are not entirely reliable; and the experience of the armed forces in selecting officers during the War showed that better results were obtained when the interview was supplemented by practical 'situation' tests, particularly group tests. Further experiment and some modification of the methods may be required; but the technique undoubtedly offers one of the most promising approaches yet devised for assessing personal qualities, and should be adopted for selecting candidates who are to be chosen mainly on personality.

For all these encouraging signs of change, there are two features which suggest that the recommendations of the Select Committee on National Expenditure five years ago have as yet had little effect. The establishment work of the Civil Service still appears to compare most unfavourably with that of the best large firms; the re-allocation of staff lags far behind changes in the volume of work, and the allocation of individual officers often takes little account of particular qualities or of personal preferences. Such failings will not be rectified until establishment work is regarded as of the first importance and is therefore assigned to officers of the highest ability. Courses of training in modern methods of personnel and business management would be a useful supplement, and in this field at least the suggested Administrative Staff College might well make a valuable contribution towards increasing the efficiency of the Civil Service.

On the professional, scientific and technical classes of the Civil Service, Political and Economic Planning in this broadsheet merely observes that the method of selection, designed primarily to assess a candidate's professional ability, seems to be adequate, and that conditions of service and salaries for scientific workers are now attracting many men and women who might otherwise have taken up academic appointments, So, too, of the Colonial Service, the broadsheet sees no reason to doubt that the courses of training. comprehensive and imaginative in scope, which have been entrusted to the universities, will be well conducted; and suggests that the Foreign Service should devote equal care to planning the training of new recruits, including suitable courses at universities in Great Britain and abroad. In particular, the six months training which it is already proposed should be spent in the study of economic, industrial and social questions will require very careful planning. It will not be enough for officers merely to tour Government departments and industrial concerns. Such visits should be the practical complement of an academic course.

The two final conclusions of this broadsheet bring us right back to the Prime Minister's statement. First, there is the warning against sacrificing training schemes to a desire to cut staff. Training makes for a more efficient staff, and an efficient staff can do the same amount of work with fewer workers than an inefficient one. Whatever decisions of policy the Government may take which affect the amount of work required of the Civil Service, the man-power of the country as a whole demands that the most efficient use shall be made of everyone who enters the Civil Service at whatever level, and that no one shall be retained who is unsuitable for his or her work or engaged in duties that are no longer indispensable.

For the same reason, the second conclusion is vital. Methods of recruitment and training should be reviewed from time to time in order that they may be adapted to changes in the national system of education and in the functions of the Civil Service. That, however, is only a small part of that long-neglected recommendation of the Tomlin Commission concerning surveys forming part of a systematic and periodic overhaul of the machinery of Government, to which the Select Committee directed attention. There is no suggestion in the Prime Minister's recent statement that any importance is attached to such efficiency audits at any level, and yet they are at least as essential as when the Select Committee reported in 1942.

It is idle for the Government to call so loudly for increased efficiency in production unless it insists on its own departments, such as the Post Office, making serious efforts to relate the loss of productive efficiency in the country caused by delays in essential services with the man-power savings in the staff reductions that have been made. It may be that all the possibilities of re-organisation and other factors in the General Post Office have been considered and correctly weighed; but the public is entitled to be told, and all the more for the overwhelming amount of goodwill towards this department which was manifest in the recent debate. The existence of such goodwill is one vital factor in obtaining the right kind of staff in any part of the Civil Service, and in maintaining its keenness and efficiency when recruited. No amount of care expended on recruitment or training can compensate for mistakes in policy and administration by the Government itself, which dissipate public goodwill and also the incentive inside the Service coming from the satisfaction of a visible public need and its generous appreciation.

BIOCHEMISTRY OF CANCER

Biochemistry of Cancer

By Jesse P. Greenstein. Pp. viii+389. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 7.80 dollars.

THE deficiency in books on laboratory cancer research is particularly unfortunate since so many new workers are turning their attention to the problems of malignant disease. The present volume is therefore assured of a wide welcome, representing as it does a valuable, indeed indispensable, addition to the cancer literature. The fact that this book follows so soon after K. Stern and R. Willheim's "The Biochemistry of Malignant Tissues", which was published in New York in 1943, illustrates the great attention now being given to biochemistry in relation to cancer in the United States, where it is widely felt that the more dynamic approach to the problems of normal and malignant growth which biochemistry supplies should be fully developed to supplement and reinforce the well-tried methods of classical histology.

It is instructive to compare these two recent books, both of which are good of their kind though entirely different in content and in mode of thought. Stern and Willheim set out to write a conventionally planned systematic work of reference, classified under tissue components and seeking completeness, and therefore largely uncritical in the selection of data. Dr. Greenstein, on the other hand, has exercised much discrimination in what he includes, and the whole book is strongly flavoured with a vigorous and critical personality and a decidedly individual outlook. His choice of material will not please everyone, and the emphasis which he puts on very recent work (the book is fully up to date) sometimes leads to the exclusion of older and more basic investigations and may thus give some readers an unbalanced view of the subject. For this reason a combination of the study of these two books has much to recommend it. Dr. Greenstein's numerous tabulations of a wide variety of numerical data are particularly useful, and his method of approach undoubtedly possesses the great advantage of avoiding that tedious chronicle of confirmatory, and alas of contradictory, observations which are characteristic of most books on cancer. In this subject the temptation to jump ahead of the available data is only to be resisted by the strongest self-control, and in this respect the modern worker ought to be in a much better position than his predecessors, many of whom were obliged to restrict their experiments to a few mice. One of the great merits of the National Cancer Institute at Bethesda, of which Dr. Greenstein is head biochemist, is that it possesses facilities and staff covering the whole range of scientific activities needed for cancer research. How great a contribution this large-scale organisation of research has made to the biochemistry of cancer is made abundantly clear in this book, though the author is under no illusion that new discovery, as distinct from the application of known principles, can ever be mass-produced (see p. 375).

After a brief introductory chapter on the origin, transmissibility, and general nature of cancer, the three main sections deal with induction of tumours (108 pp.), controlling factors (34 pp.), and properties (200 pp.). In the first of these, the extrinsic factors, including the known chemical and physical carcinogens, are described; a rather brief account of the pioneer investigations of E. L. Kennaway, J. W. Cook, and their colleagues at the Cancer Hospital being followed by a somewhat more detailed description of the subsequent American work. This is succeeded by a useful section on the metabolism of the carcinogens in the animal body, a matter which may help to explain the differences in carcinogenic power found in different species. The reviewer may perhaps mention that the explanation suggested for the loss of carcinogenic power of benzpyrene when dissolved in solvents containing phospholipins (see p. 63) does not hold for experiments in which the amount of benzpyrene actually injected was determined by analysis (F. Dickens and H. Weil Malherbe, *Cancer Research*, 2, 560 (1942); 4, 425 (1944); 6, 161, 171 (1946)).

Under the heading "Intrinsic Factors" is a useful account of the influence of sex-hormones and of the mammary tumour inciter, the milk-borne factor discovered by J. J. Bittner in 1939, which renders certain strains of mice liable to breast cancer when they become older. Although no evidence yet indicates that this observation applies to other species, probably most cancer workers would attribute to it higher importance than Dr. Greenstein gives it here, if only because of its remarkable theoretical significance. The same applies to the interesting observation, now fully confirmed, that cancer can be induced in mice by suitable extracts of human tissues. Although the activity of such extracts is rather feeble, and it is not yet proved that the carcinogenic properties do not arise through alteration of the extracted substances during the manipulations, it seems to be going too far to suggest (p. 134) "that the results merely demonstrate the relative susceptibility of mice to carcinogenic agents of most any and all sorts (*vide infra*)". One has the impression that much of this book was hastily written, for example, the frequent use of *vide infra* for references to earlier pages, the occurrence of uncorrected printing errors, and the occasionally confusing English, as on p. 260, where the account of the cytochrome system is difficult to follow. This is a pity, for the excellent material deserves a more careful presentation.

The final chapters on the properties of tumours contain the most comprehensive account of the enzymic distribution in cancer tissue which has yet been written, and coming from one who has himself made valuable contributions to this subject, this authoritative section would alone have justified the publication of the book. As in the other chapters, full bibliographies are included, and there are author and subject indexes. The general conclusion is that the cancer cell is working with most of its enzymic machinery fully extended to meet the demands upon it, and has therefore less reserves of metabolic catalysts available than the normal cell possesses. This is an important generalization, and, if it stands up to further critical experiments, may perhaps form the basis of a future scientific therapy of cancer.

F. DICKENS.

DIET AND VITAMINS

The Nation's Food

A Survey of Scientific Data. Edited for the Society of Chemical Industry (Food Group) by A. L. Bacharach and Theodore Rendle. Pp. xvii+349. (London: Society of Chemical Industry, 1946.) 18*s*. net.

Vitamins and Hormones

Advances in Research and Applications. Edited by Prof. Robert S. Harris and Assoc. Prof. Kenneth V. Thimann. Vol. 4. Pp. xvii+406. (New York: Academic Press, Inc., 1946.) 6.80 dollars.

HERE are two volumes which no serious worker on nutrition can be without. In "The Nation's Food" will be found an authoritative summary of almost all that is at present known about the nutritive value, and the chemical and even physical properties, of British foods. The first section of the book deals with the egg as food, the second with the potato as food, the third with vegetables as food; and parts four, five, six and seven, respectively, with cereals, meat, fish and milk, all treated "as foods". Thus no important article of diet is omitted. Each of these seven sections is further subdivided, in a methodical manner, into a series of chapters, dealing in turn with such aspects as the biology of the food in question, its chemistry, nutritive value, production, effect of cooking, storage, and so on. These chapters—twenty-seven in all—are contributed by the leading experts in each field; and thus the book is bound to be useful both to the specialist, who will need it for reference and for study, and also to those whose interests are more general, including, no doubt, caterers, dietitians and food manufacturers.

The Food Group (and its Nutrition Panel), a constituent section of the Society of Chemical Industry, under whose auspices the papers published in this book were originally delivered as a series of lectures, are deserving of our warmest thanks. So also, assuredly, are the authors and the editors, who have gone to so much trouble in their work of extending, revising and editing their manuscripts since these lectures were first given, in order that we may now have their expert knowledge before us for our more permanent use.

"Vitamins and Hormones" is likewise an authoritative compilation by a number of experts; and volume IV, the latest to appear, will be as welcome as were the earlier numbers, and will be needed by all those departmental libraries which specialize in these branches of science. The plan here is somewhat different from that of the book first reviewed, for in "Vitamins and Hormones" contributions are published not in any logical sequence but in the necessarily more fortuitous order in which they could be commissioned and delivered. Thus volume IV is made up of the following contributions in order: "The Newer Hematopoietic Factors of the Vitamin B-Complex", by J. J. Pfiffner and Albert G. Hogan; "Nutrition and Resistance to Infection: the Strategic Situation", by Howard A. Schneider; "Manifestations of Nutritional Deficiency in Infants", by F. W. Clements; "Effect of B Vitamins on the Endocrinological Aspects of Reproduction", by Roy Hertz; "Nutritional Therapy of Endocrine Disturbances", by Morton S. Biskind; "The Thyroid and Diabetes", by Bernardo A. Houssay; "Thyro-active Iodinated Proteins", by E. P. Reineke; "The Protein Anabolic Effects of Steroid-Hormones", by Charles D. Kochakian; "Methods of Bioassay of Animal Hormones", by Sidney A. Thayer.

The style and standard of the contributions vary considerably: some of them are relatively exhaustive in scope, some less so; some are in the form of critical appraisals of the present outlook, whereas others are more in the nature of a collection of abstracts. A useful feature is the system of headings, sub-headings, and sub-sub-headings, which appear both in the table of contents, and in the actual review article itself. This makes for ease in consultation. For example, in the review on "Methods of Bioassay of Animal Hormones", by Sidney A. Thayer, "Section IX" of the review is concerned with "Bioassay of Adrenal Cortical Hormones", "Section IX: 2" with "Bioassay of Adrenal Cortical Hormones: Deposition of Glycogen in Fasting Adrenalectomized Rats", "Section IX: 2, a" with "Bioassay of Adrenal Cortical Hormones: Deposition of Glycogen in Fasting Adrenalectomized Rats, Experimental", and "Section IX: 2, a-γ" with "Bioassay of Adrenal Cortical Hormones: Deposition of Glycogen in Fasting Adrenalectomized Rats, Experimental—Final Assay Procedure".

Not very many workers on vitamins are active in the field of hormones, or *vice versa*, and some readers may have questioned the practical advantage of joining the two subjects together in the one periodical. In their preface to the present volume, the Editors take up this very point. They refer to the "increasing interrelationship between vitamin and hormone research", which as they say is "exemplified in three articles in the present review". They therefore conclude that this "justifies the Editors' initial feeling that the bringing of reviews of these two fields under one cover would prove realistic and helpful". LESLIE J. HARRIS

GEOLOGICAL GUIDE-BOOK OF OXFORD

The Geology of Oxford

By Dr. W. J. Arkell. Pp. viii+268+6 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 20*s.* net.

NEARLY eighty years ago there issued from the Clarendon Press Phillips' "Geology of Oxford and the Valley of the Thames", a classic among geological guide-books. Here, from the same Press, with a shortened title and reduced bulk, appears another. Stratigraphers who possess, and perpetually consult, Dr. Arkell's "Jurassic System" will not need to be assured that "The Geology of Oxford" is an erudite, documented and yet readable book. Although the area dealt with in detail is comprised within a ring of some thirty miles radius around Oxford, comments and comparisons range over Europe and beyond, so that the book provides a sketch of Mesozoic and later stratigraphy in which one small portion is elaborated. It is essentially a book for students, but for students everywhere.

A concise first chapter introduces the Palæozoic platform on and about which the main subject-matter is to accumulate. The contrast between "Palæo-Europe" (on which Oxford stands) and "Meso-Europe" (which is attached to it along the south side of the Mendip–Ardennes line) explains the diversity of the post-Triassic sedimentary history of the area.

The remaining seventeen chapters treat of the deposition, classification, deformation and disposition of the rocks of the successive periods. It is refreshing to find in their headings the good old English names that nowadays are so often lost in the intricacies of zonal nomenclature. There is nothing old-fashioned in the chapters themselves. Each starts with an uncompromising list of the zones, followed by a summary of the local and regional characteristics of each. Then come the local details; there can be few exposures within the chosen area that are not analysed with meticulous care. It is a testimony to the author's style that even these purely descriptive paragraphs, lists of fossils and all, make interesting reading.

The first ten chapters constitute an amplification, with slight revision, of the corresponding parts of the author's "Jurassic System". Such modifications in classification as appear in this newer account result, on the whole, in simplification. In the chapters dealing with the Cretaceous and Tertiary systems there seems to be an increased reliance on the work of others; these chapters are summaries of diverse opinions rather than expressions of personal conviction. This in no way lessens their value to the student, nor does it exclude ingenious and provocative comments. The author seems to accept, with but little reservation, the latest heresies in respect of the Chalk, its origin and its flints. That the Chalk Sea was relatively shallow is as sound a deduction as that it was extremely wide; but it is hard to believe that an area of water covering most of Europe could have permitted desert conditions to prevail over the surviving patches of land. Coastal sand-dunes do not necessarily imply a Saharan hinterland. Again, the author is content to postpone the segregation of silica into flints until the Montian stage (with a second gathering in the late Miocene period). While it must be admitted that much flint has 'grown' in the Chalk since Cretaceous times (it may, indeed, be forming still), some of it must surely be contemporaneous. The unshrivelled form of the ectosarc of sponges, or the ampullae of Echinoids, to mention but two common occurrences in 'flint-fossils', must have received their 'petrifying' coating within a few hours of death.

The chapters on the Pleistocene recover the personal touch and provide much valuable information and correlation of local developments. Many of the interpretations may be debatable; but that is normal for the period.

The index is a model of its kind and ensures the value of the book as a work of reference. The text-figures are adequate and clear, the author's drawings of fossils being particularly good. The plates are perhaps less satisfactory, but they are few. It is strange to find as the frontispiece to a work on Oxford a touched-up aerial view of White Horse Hill, the 'Mecca' of the men of Berkshire. But it will be realized that if criticism is reduced to such trivial points, the real reaction to this book is one of unstinted welcome; every serious student of stratigraphy, whether he works near Oxford or not, will find its facts indispensable and its arguments stimulating. H. L. HAWKINS

STRUCTURE OF SPECTRAL LINES

High Resolution Spectroscopy
By Dr. S. Tolansky. Pp. xi+292+4 plates. (London: Methuen and Co., Ltd., 1947.) 21*s*. net.

THE author of this book has given an account of the experimental techniques used in the investigation of the structure of spectral lines; but he has not stated in the introduction whether it is intended to be primarily a historical account or to be a text-book giving a critical description of methods now in use, and the book suffers from a confusion of these points of view. On one hand, there is lacking an account of the work which has been done in the past with the methods described, and on the other hand, obsolete instruments are described in too much detail; and avoidable inaccuracies seriously reduce the value of the book from both of these points of view. In spite of the length of the book, important experimental details have been omitted, too much space having been devoted to academic theoretical considerations.

The first five chapters contain a detailed account of the light sources used for obtaining narrow spectral lines; but a summarized comparison of the advantages and limitations of the different methods is not given. The description of the hollow cathode tube is concerned too much with complicated and obsolete forms of this light source. In the account of the atomic beam the advantages of the method of observation in absorption have not been fully appreciated. For example, it is stated on p. 82, "it is therefore very easy to miss weak components . . .", while in fact it is one of the merits of this method (as of all absorption methods) that it is specially suited to the observation of weak components (the weak components in the potassium resonance lines, due to the rare isotope K41, have been found in absorption, whereas they are not observable in emission).

The last ten chapters are concerned with the optical instruments used for the examination of the structure of spectral lines. A comparison is made between four instruments, the Fabry–Perot etalon, the Lummer–Gehrcke parallel plate, the echelon grating and the ruled grating. The general superiority and greater scope of the etalon is rather understated, and a quantitative comparison of the intensity of the spectra given by these instruments should not have been omitted. The detailed description of two methods, sputtering and evaporation, for preparing the metallic layers for the plates of an etalon is misleading; the impression is given that the former is a method which would still be used, while it has, in fact, been rendered obsolete by the latter. Though very few, and contradictory, measurements are available concerning the reflecting power of transparent layers of silver and aluminium, this property is made the basis of six different graphs, thus giving a wrong idea of the facts. The most important part of all of these curves, that referring to dense layers as actually used, has been reproduced from data which do not pretend to a high degree of accuracy, and is unfortunately badly wrong. Thus as a consequence of conclusions drawn from the curve giving the relationship between the reflecting power of a layer of silver and the intensity of the maxima of the fringes, it is stated: "The curve has a steep fall in the important region of 0·85 upwards. It is significant to note that an increase in reflecting coefficient from 0·85 to 0·87 (only two per cent) leads to a 50 per cent reduction in intensity. . . . The region in the neighbourhood of the 0·85 reflecting coefficient is therefore highly critical and considered judgment is necessary in preparing such films." If the curve had been drawn correctly it would have shown that the rapid fall in intensity occurs when the reflecting power becomes greater than approximately 0·95. The use of silver layers of this higher reflecting power is of the greatest importance, since it involves an increase by a factor of three in the resolving power and a reduction by a factor of approximately ten in the intensity of the background. The production of evaporated layers of the correct density is necessary for obtaining high resolving power without loss of intensity, and this can be done without the need of "considered judgment" by photo-electric measurement of the density during the course of the evaporation (using the correct value for the reflecting power); but this method is not described.

In the chapter concerned with the compound etalon, too much space is given to theoretical calculations of the properties of this instrument; a description of some of the results which have been obtained and an account of the experimental details of the methods of adjustment would have been of more value. In the discussion of the limitations with regard to the intensity of the fringes and the strength of the subsidiary maxima, the value of this instrument is much underrated on account of the assumption of wrong values for the reflecting power of silver layers and the corresponding intensity of the fringes, taken from the incorrect curve referred to above. A reflecting power of 0·8 is assumed; in fact, a reflecting power of 0·9 can be used without serious loss of intensity; there is then a reduction of the intensity of the subsidiary maxima to a small fraction of that for a reflecting power of 0·8.

The description of the echelon grating lacks an account of the work which has been done with this instrument, and fails to emphasize the importance of its limitations due to the weakness of the spectra as a result of the need for an objective of very long focal length; the advantage of the simplest form of mounting which reduces loss of light are thus underestimated. The discussion of the aberration which would be introduced by this mounting if an objective of short focal length were used is irrelevant, since the limitations due to the grain of the photographic plate preclude the use of a short focal length.

The scope of the photographs at the end of the book is rather limited, since the author has not reproduced photographs made by other workers.

Although serious errors and omissions reduce its value, this book contains much information useful for workers in high-resolution spectroscopy concerning which no comprehensive treatise has hitherto been available. D. A. JACKSON

CENTENARY OF THE CHEMICAL SOCIETY

THE Chemical Society is entitled to be congratulated on the whole programme of events arranged in celebration of its centenary during July 15–17. There were receptions and a programme of visits, and three excellent lectures besides the centenary address, all appropriate and all well arranged, and many of them displaying the same leading ideas that marked the opening ceremony and the centenary address. The first official function was indeed the opening of an exhibition illustrating one hundred years of British chemistry at the Science Museum, South Kensington, by the president of the Society, Prof. C. N. Hinshelwood, on July 14. The Minister of Education, who took the chair at the opening ceremony, emphasized not merely the vital place of the learned societies in the cultural and educational life of the community and the landmarks in the progress of chemical science to be seen in the exhibition, but like Prof. C. N. Hinshelwood, the dependence of such achievements upon men of independent, vigorous and original minds in the past.

Prof. J. Read, in his lecture at the Institution of Civil Engineers on "Chemical Personalities a Century Ago" on July 16, took a longer look at some of the founders of modern chemistry, and Prof. E. K. Rideal, lecturing simultaneously at the Royal Institution on "The Work of the Royal Institution in Physical Chemistry in Great Britain", also paid tribute to many honoured names such as Humphry Davy, Faraday, Dewar, Sir William Bragg and Sir Henry Dale. Equally, Sir Robert Robinson, in the Faraday Lecture delivered in the Central Hall, Westminster, on the afternoon of July 16, on "The Development of Electrochemical Theories of the Course of Reactions of Carbon Compounds", linked modern ideas on the electrolytic dissociation of acids and the applications of these principles to the benzene ring and theory of partial valency with the work of Faraday, in whose laboratory at the Royal Institution during Faraday's active experimental life of some forty years, fifteen major investigations were undertaken, all of which had a profound effect on physical chemistry as we know it to-day.

The dominant impression left by Prof. Read's lecture was exactly that of the international unity and fellowship which was such a distinctive feature of the dignified and impressive opening ceremony of the celebrations in the Central Hall the previous day. Prof. Read showed how those chemists who founded the Society formed part of a movement which recognized national frontiers no more than the wandering scholars of the Middle Ages, and which even then was throwing up schools of chemistry which attracted men from all over the civilized world. The birth of the Chemical Society was the outcome of an intellectual ferment as international in character as the gathering which saluted its birth. Prof. Rideal's lecture, on the other hand, illustrated incidentally the reciprocal influence of the Chemical Society on other scientific societies and institutions. The Chemical Society, as Sir Robert Robinson pointed out, in conveying greetings to the Society from the Royal Society and the other learned societies of Great Britain, had not merely stimulated the formation of other bodies such as the Biochemical Society and the Faraday Society, but had also contributed to the advancement of knowledge in many diverse fields, as was illustrated by that with which the Society of Dyers and Colourists was concerned. The influence, as Prof. Rideal noted in commenting on the fact that five of the professors in the Royal Institution had been presidents of the Chemical Society, was reciprocal, and the Chemical Society owed much to the labours of other societies.

The names in the list of some forty societies and institutions in Great Britain on whose behalf Sir Robert Robinson offered felicitations to the Chemical Society testified to the ramifications of chemical science during the century and to the industries which had been stimulated or transformed by chemical enterprise, and the proceedings on the Tuesday, above all at the opening ceremony and the centenary address, seemed to epitomize the essential spirit of the celebrations. There was colour as well as dignity in the processional entry of the delegates representing overseas Societies, headed by the president, and preceded by the Society's mace-bearer. The president's words of welcome to the representatives of nearly thirty countries were well chosen, touching briefly on the unity of science. Prof. Raymond Delaby, speaking on behalf of these delegates, responded in French. The addresses formally presented by these delegates and by the representatives of British Societies were not read at the meeting but were displayed in the Society's rooms at Burlington House, where they were to be seen at the Royal Society's reception. Mention might be made here, however, of the Swedish glass vase bearing suitable inscriptions and illustrations of chemical equipment which contained the address of the Chemical Society of Stockholm.

If the centenary address of Prof. Hinshelwood on July 15 is given pride of place it is only because it gave fuller expression to the charm of manner and keenness of thought which marked his tenure of the presidential chair throughout the celebrations. If the founders of the Society might have found it beyond their wildest dreams to expect that the head of the Government of the day would honour the Society by his presence at the centenary dinner and that the fellows of the Society and the overseas delegates should enjoy Government hospitality at the luncheon on July 15 and the garden party at Lancaster House on July 17, the explanation is at least in part to be found in the president and those like him who have linked to their scientific attainments such charm and courtesy and organising ability. That much at least can be glimpsed in his centenary address, which will worthily commemorate the celebration long after the memory of the social events and festivities is dim.

Touching briefly on the philosophical questions raised by the celebration of the centenary not of a discovery or of a person, but of a Society, he reviewed in succession the chemical scene at the foundation of the Society and at successive intervals of a generation before, attempting to discern the essential trends to which great events and personalities are related more as occasions than as causes. Here Prof. Hinshelwood challenged thought about some of the central issues of our time and formulated our task of preventing an organised society from turning individuals into slaves with all the implications for the relation of the State to science, of industries to the universities, for the organisation of research laboratories and, indeed, for the relation of every scientific worker to the laboratory in which he works and to the science as a whole. Complete individualism means chaos, but it is still the individual who counts; but his problems are different, and at every level in every organisation where men engaged in scientific pursuits those in charge must continue to wrestle with the problems of combining liberty with order to the end of finding that course which is humanly as well as technically the most effective.

Pragmatic as well as suggestive, Prof. Hinshelwood was never doctrinaire, but he did not hesitate to follow his words of appreciation for the increasing number of scientific papers coming from chemical industry, with a warning of the dangers in which military security might involve us or against the restrictions on scientific publication imposed by paper stringency or to plead for adequate facilities for meetings, and in this address he returns in conclusion to the international character of the Society and to the fellowship of those who share the love of chemistry which was so manifest at the celebrations.

Welcome as may be the generous appreciation of the work of the Society manifest in the addresses of felicitation, the hospitality extended to its fellows and guests at the receptions, visits and social functions, it is to the spirit which pervades the centenary address that we must look chiefly for the firm assurance that the second century on which the Society has entered will be no less noteworthy than that celebrated in July 1947.

ELEVENTH INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY

THE Eleventh International Congress of Pure and Applied Chemistry was held in London during July 17–24, following immediately on the centenary celebrations of the Chemical Society. Some three thousand members and delegates, including many leading personalities in all branches of chemistry, and representing thirty different countries, took part in what must have been the largest international gathering of men of science since the end of the War. A crowded programme had been arranged, consisting of meetings for the reading and discussion of papers, lectures, visits to industrial laboratories and many social events.

More than 1,500 papers were submitted for presentation. For the purpose of reading the papers selected, the Congress met in fourteen sections, representing the various branches of pure and applied chemistry. Several sessions were held jointly between different sections, and the majority of contributions were in the nature of reviews of work already published, or in the process of publication, rather than entirely new material. It is obviously impossible to give more than a very brief indication of the vast amount of ground covered. Only a small fraction of individual contributions can be mentioned, but it will be useful to summarize the main topics of discussion as they provide an excellent indication of contemporary trends in chemistry.

In Section 1 (Inorganic and Geochemistry) the first session was devoted to reactions in solids and X-ray methods, and included a general review by J. A. Hedvall of progress in this field over the last thirty years, and an account by H. L. Riley on the X-ray crystallography of amorphous carbon. At a later session, entitled "Structural Chemistry of Metals and Inorganic Compounds", L. Pauling outlined a new theory of the metallic state. Treatment of interatomic forces in metals by the method of atomic orbitals provides a qualitative explanation of the special properties of the transition metals. Other speakers discussed recent work on the structure of mixed crystals (P. Niggli), molecular compounds (H. M. Powell) and electron-deficient molecules (R. P. Bell). Further sessions dealt with geochemistry and the structure of minerals, and with radiochemistry, and included papers on francium (element 87) (M. Perey), and on protactinium (G. Boussières and H. Haissinsky). The disappointing fact that any direct reference to subatomic phenomena was excluded, brought to mind the centenary address of the president of the Chemical Society in which he expressed the hope that "the whips of commercial secrecy would not be succeeded by the scorpions of military security" in preventing the publication of research.

In Section 2 (Physical Chemistry) there were symposia on polymers, catalysis and reaction-rates, and spectra. The latter was almost wholly concerned with the absorption spectroscopy of organic compounds. The striking developments in the technique and applications of measurements in the infra-red region were reviewed by J. Lecomte, G. B. B. M. Sutherland and H. W. Thompson. E. Clar discussed the ultra-violet light absorption of aromatic hydrocarbons, and J. M. Robertson the determination of bond-length by X-ray methods. In the session on polymers, held jointly with the Textile and Elastomers Sections, about an equal number of papers were devoted to structural and kinetic aspects. H. W. Melville described the synthesis and properties of a new branch-chain type of polymer built up from cruciform and star-shaped molecules and obtained by condensing together adipic acid, ethylene glycol and a small amount of a polyfunctional alcohol, such as penta-erythritol. Two papers by H. Mark dealt with the mechanism of polymerization reactions and the configuration of polymer molecules. The composition of a binary co-polymer is related to the electron-availability at the radical end of the growing chain and at the double bond of the monomer molecule, and can be predicted from the electronic character of the substituents. J. B. Speakman described the modification of the properties of natural fibres by chemical means, for example, by successively breaking and re-uniting the cysteine cross-linkages in keratin with reducing and oxidizing agents, and by physical means. Among the topics covered in other sessions were those of mass-spectrometry, magnetochemistry and polarography, and included papers on the measurement of the rate of electrode processes by oscillographic methods (J. Heyrovsky), the thermal and photo-oxidation of olefins (I. Bateman and J. L. Bolland) and the absolute velocity of contact catalysis (G. H. Schwab).

The programme of Section 3 (Organic Chemistry) covered general organic chemistry, heterocyclic compounds, antibiotics, vitamins and growth factors, and theoretical organic chemistry, and included many contributions of outstanding interest. Of special significance from the international point of view was an account by G. M. Dyson of his new system of notation for organic compounds, which has many advantages over the rather loose nomenclature at present in use. Any compound, however complicated, can be ciphered uniquely, the number of symbols required being on the average less than half of those used with the Geneva Convention, and the ciphers are admirably suited for mechanical indexing and sorting methods. Five papers on penicillin by H. C. Carrington, K. Folkers, Sir Ian Heilbron, D. Crowfoot Hodgkin and V. du Vigneaud, and their collaborators, provided a fascinating story of what is probably the greatest concerted effort yet made by organic chemists. Of the two rival thiazolidine-oxazolone and thiazolidine-β-lactam structures, the latter is now accepted, mainly on the basis of physical evidence; but the only definite synthesis so far achieved, though in minute yield, is based on the former. The synthesis of vitamin A, a goal which for so long defied the attempts of several groups of workers, was announced by D. A. van Dorp and J. F. Arens (see also *Nature* of August 9, p. 189), and by O. Isler. The determination of the constitution of streptomycin was outlined by K. Folkers. Sir Robert Robinson discussed recent work in the strychnine group of alkaloids. The isomerization of strychnine into neostrychnine has been recognized as a simple prototropic rearrangement, and leads to a new structural formulation. Other notable contributions included the synthesis of compounds related to the auxins (E. R. H. Jones) and to pyridoxin (vitamin B_6) (A. Cohen), degradative work on amyrin (L. Ruzicka), the potato eelworm hatching factor, ecleptic acid (A. R. Todd), and testosterone (P. A. Plattner), the constellation of many-membered ring ketones (V. Prelog), and of the configuration of the hydroxyl group in cholesterol (C. W. Shoppee), the synthesis of pyrimidines (F. H. S. Curd and F. L. Rose) and of xanthines (F. S. Spring), and addition reactions of nitro-olefins (J. D. Rose), and of halogen-containing compounds to olefins (M. S. Kharash). Theoretical organic chemistry was represented by papers on the kinetics and mechanism of aromatic nitration (C. K. Ingold) and halogenation (J. P. Wibaut), the mechanism of oxidation reactions (W. A. Waters), the X-ray analysis of cyclo-octatetrene (H. Mark), and others.

In Section 4 (Biochemistry) there were sessions on enzymes and enzyme action, macromolecules of biological interest, intermediary metabolism, and proteins and protein analysis. J. D. Bernal spoke on the structure of the protein molecule, a picture of which is now slowly emerging by the combined attack of electron microscopy, X-ray and chemical analysis. F. Sanger described a new method of estimating the length of polypeptide chains in proteins and of identifying individual amino-acids by reacting the free amino-groups with 2 : 4-dinitrophenylfluoride, and separating the coloured derivatives by partition chromatography. M. Stacey gave an account of bacterial polysaccharides and H. N. Rydon described studies which indicate that hydrogen-bonding may be an essential feature in the combination of bacterial enzymes with their substrates. The emphasis in metabolic studies was on the use of isotope tracers. V. du Vigneaud presented evidence that only the sulphur but not the carbon of methionine is used in the synthesis of cysteine in rats. Studies employing radioactive phosphorus and iron indicate that there is a rapid migration of phosphorus from the plasma into the red blood corpuscles, and that average lifetime of the latter is about one month in the hen and four months in man (G. von Hevesy). The fate of mustard gas in the animal body and the mode of action of B.A.L. (British anti-lewisite, 2 : 3-dimercaptopropanol) has been investigated using radioactive S^{35} (G. E. Frances and A. Wormall, L. Young). M. el Shahat announced the discovery of a new 'H'-lactation promoting factor which is not a tocopherol.

Sections 5 and 6 (Chemistry in Relation to Agriculture and Applied Botany, and to Applied Zoology and Veterinary Science) held symposia on soil fertility, plant nutrition and fertilizers, animal nutrition, composition and quality of milk, insecticides and fungicides, and the chemotherapy of protozoal infections. Several speakers, among them H. R. Marston, R. L. Mitchell, S. A. Waksman and E. J. Underwood dealt with the role of trace elements, such as copper, selenium and cobalt, a subject on which very diverse views are still held in different countries. J. H. Quastel described his recent work on the role of manganese in biological oxidation in the soil. S. J. Rowland reported a steady decline in the solid protein content of English milk, and seasonal variations in the composition of milk in Norway and India were discussed by G. Aas and K. C. Sen. H. Hurst attributed the mode of action of D.D.T. to the indirect blocking of the cytochrome oxidase and succinic dehydrogenase systems by the storage of insecticide in the phospholipoids of the cell membranes, while H. Martin directed attention to the parallelism between the ease of dehydrochlorination and insecticidal activity in D.D.T. analogues. The chemotherapeutic uses of amidines and of phenanthridinium compounds were reviewed by H. J. Barber and by L. P. Walls.

In Section 7 (Chemistry in Relation to Food and Nutrition) Sir Jack Drummond introduced a topical discussion on the effects of dietary restrictions in man. J. R. Marrack, in dealing with the question of how can we know whether our food is doing us good, considered that the most reliable answer was provided by functional tests, for example, the level of hæmoglobin and ascorbic acid in blood, and the height and weight of children, rather than by vital statistics. A. Neuberger introduced a discussion on the role of amino-acids in nutrition. Isotope tracer experiments have established the extraordinary speed of nitrogen exchange between proteins and the dietary supply. Experiments which establish the function of methionine as a source of labile methyl groups were described by V. du Vigneaud and by L. E. Glynn. D. P. Cuthbertson discussed the marked catabolism of body protein following traumatic injury as revealed by the losses of nitrogen and sulphur in the urine.

Section 8 (Chemistry in Relation to Medicine and Therapeutics) covered a wide range of topics. Sir Howard Florey introduced a symposium on antibiotics. The rapid developments in this field are exemplified by the isolation from actinomycete cultures of more than a dozen antibiotics besides streptomycin (S. A. Waksman), and the production of a variety of compounds effective against *M. tuberculosis* by *Fusaria* (A. H. Cook). In a session on industrial toxicology, B. C. Saunders reviewed the toxic properties of fluorine compounds such as the fluorophosphonates and fluorocarboxylic acids $F.(CH_2)_n.CO_2H$. The latter are harmless when n is even, but toxic when n is odd. R. A. Peters discussed the reactions of B.A.L., and R. Spence and A. G. Maddack outlined the design of a radiochemical laboratory in relation to the protection of the health of the staff. Two further sessions, entitled "Endocrinology and Carcinogenesis" and "Drugs and Chemotherapy", included papers on doisynolic acids (K. Miescher), œstrogens related to triphenylethylene (W. Tadros), carcinogenic agents of the *p*-aminostilbene type (G. A. R. Kon), the relation between physico-chemical properties and bacteriostatic properties of acridines (A. Albert) and the empirical and rational approach to chemotherapy, as exemplified by the work culminating in the discovery of the antimalarial paludrine (F. H. S. Curd and F. L. Rose).

In Section 9 (Chemistry in Relation to Fuel, Power and Transport) there were discussions on many aspects of the production of solid and liquid fuels, carbonization and gasification, and combustion. Among topics which attracted special attention were gas turbines and underground gasification. Sir Ernest Smith addressed a meeting on the training of chemists for the fuel industries. In Sections 10, 11 and 12 (Chemistry in Relation to Natural and Artificial Textiles, to Elastomers, Plastics, Glass and Ceramics, and to Metals) the predominant tendency was towards fundamental investigations as an aid to the solution of practical problems. The academic approach was typified by contributions on the properties of seaweed rayon (J. B. Speakman), deuterium exchange in cellulose (H. Mark), the theory of crystallization and plastic flow (Sir Lawrence Bragg), the intrinsic viscosity of polymer solutions (P. Debye), the effect of crystallization on the mechanical properties of high polymers (G. Gee), the network theory of rubber (W. Guth and H. M. James), sorption kinetics (R. M. Barrer), the thermodynamics of metallurgical extraction processes (H. J. T. Ellingham), and the electrochemical mechanism of corrosion (U. R. Evans). Section 13 (Chemical Engineering) held a symposium on educational aspects, as well as discussions on a variety of large-scale processes, including the production of hydrogen, oxygen, heavy water and toluene.

In addition to the section meetings, Congress lectures were delivered by L. Pauling on "Molecular Structure and Biological Specificity", Sir Henry Dale on "The Part of Chemistry in the New Therapeutics", P. Karrer on "Recent Advances in Organic Chemistry", A. Tiselius on "Recent Developments in Electrophoresis", L. Hackspill on "Calcium Carbide and its Reducing Properties", and by B. C. P. Jansen, who took as his subject "*Simplex non veri sigillum*".

The second, equally important function of the Congress, namely, to promote and extend the invaluable personal contacts between chemists of different countries, was well provided for. Delegates and members were entertained by the Government, the Royal Society, the Royal Institution, the Chemical Society, the Royal Institute of Chemistry, the University of London, Imperial Chemical Industries, the English Speaking Union and other bodies. There were two Congress dinners, one of which was attended by the Prime Minister and Mrs. Attlee. In proposing the toast of chemistry, Mr. Attlee said that the problem of the modern world was not how to make more advances in science, to which it owed so much, but rather, how to secure a world in which those advances could be made with safety. This indeed must have been the predominant thought of all those who took part in this Congress.

SEVENTEENTH INTERNATIONAL PHYSIOLOGICAL CONGRESS

THE Seventeenth International Physiological Congress was held in Oxford during July 21–25 under the presidency of Sir Henry Dale. It was attended by about 1,200 physiologists, including welcome delegates from the U.S.S.R. and China. The official programme was very heavy, for 350 communications, about seventy demonstrations and a number of films had to be compressed into three working days.

There were a number of excellent films, including one of hypothalamic stimulation by W. R. Hess, the isolation of a single nerve fibre by A. von Muralt, perfusion of the whole animal by I. de Burgh Daly, and colour films for teaching made with the help of Imperial Chemical Industries, Ltd., by J. H. Burn and F. R. Winton.

In earlier international congresses, it was intended that communications should be demonstrative and experimental, and memorable demonstrations have included one by Sherrington on the reciprocal innervations of antagonists, and another by Mering and Minkowski on the experimental production of diabetes. This year the demonstrations were interesting and competent, but not, perhaps, of the first importance.

For the communications, nine lecture theatres were in use simultaneously during the six sessions. This permitted the programme to be completed without trespassing on the time available for the all-important social activities, and their opportunities for personal contact.

A considerable number of communications arose from work undertaken with official encouragement in the War. Studies on respiration at high altitude, at high pressures of oxygen and carbon dioxide, explosive decompression, resistance to centrifugal force, resistance to high environmental temperature, all demonstrated the practical usefulness of physiological analysis.

Studies which were made possible by the development of new substances during the War, or which arose out of the care of war casualties, were on the whole of greater scientific importance. The application of di-isopropyl-fluorophosphonate to a variety of systems involving acetylcholine, and further controversy over the part played by acetylcholine in the transmission of the nerve impulse, the application of B.A.L. to the treatment of poisoning by arsenic and other metals, are good examples. Work on patients suffering from starvation, traumatic arterio-venous aneurysms and traumatic paraplegia has also been not unprofitable.

Perhaps the most important work reported, however, has been in independent research, in which, in Prof. E. G. T. Liddell's phrase, after seven years, members were showing an active post-inhibitory rebound. An outstanding paper was given by A. L. Hodgkin and A. F. Huxley, who suggested that during the rising phase of the action potential in nerve, the membrane becomes highly permeable to sodium ions, which then enter the cell. Potassium ions leave the cell during the falling phase and later restorative processes occur linked with energy-producing mechanisms. There was considerable indirect evidence in favour of this view. A theoretical treatment of the principal events in muscular contraction was put forward by A. Szent Györgyi, and provoked a vigorous discussion (see also p. 262).

The refinement of physical methods applicable to living organisms has progressed rapidly. Methods of measuring tissue fluid flow by radioactive helium, recording the contour of the heart by a precise radiographic and photo-electric method, continuous records of blood pressure in man by a condenser manometer, all provide powerful tools for work on the circulation. The clinical physiologists, A. Cournand, J. V. Warren, E. A. Stead, J. McMichael and E. P. Sharpey Schäfer, using cardiac catheterization, have demonstrated the similarities as well as the differences in the behaviour of the circulation in man and in anæsthetized animals.

The nature of the proteins of muscle and of the nucleus and its chromosomes has continued to occupy much attention. The central nervous system also was the subject of a large number of papers; but there were no outstanding advances in any of these fields.

The Congress accepted an invitation to Copenhagen for the Eighteenth International Congress, to be held in 1950, under the presidency of Prof. August Krogh.

On the last day, the University of Oxford conferred degrees of Doctor of Science on Profs. C. H. Best, H. S. Gasser, B. A. Houssay, August Krogh and A. Szent Györgyi.

GRASSLAND AND ANIMAL PRODUCTION

In July 1937 the International Grassland Conference was held in Great Britain, and the delegates examined closely the work and promise of the Aberystwyth nucleus, from which so much of the newer knowledge and philosophy of grassland management has spread. In the last week of June 1947, a further review of the activities of the Welsh Plant Breeding Station was made by members of the British Grassland Society and the Society of Animal Production at the first joint meeting of the two groups. This occasion, too, was given a minor international flavour by the representatives from countries overseas, who took the opportunity to refresh their contacts with workers in Britain; but, useful as this was, the greater significance of the meetings and visits lay in the interchanges of ideas and comments between those concerned on one hand with better grassland and, on the other, with better use of that grassland by the animal.

At first glance, there should be no divergence between the two aspects; clearly, however, there is. Moreover, there might appear to be a close parallel between the objectives of the animal husbandman and the agronomist: one aims to increase productivity by better nurture, better breeding, and a replacement of the less biologically efficient stock by those of greater and more reliable merit, the other at improving productivity of the plants by broadly similar means. Yet such a parallel would be deceptive as a representation of the past, and even present, courses of the two lines of endeavour.

During the last ten years great progress has been achieved in the development of plant-breeding methods and material. At all stages of the process, from the search for fresh material, its testing, experimental breeding, progeny-testing, and multiplication, to the treatment of seed, and the certification of stocks, as well as in the maintenance of proved stock plants or strains and in the trials of material from other sources in pure cultures and in mixtures, the techniques have advanced even under the difficulties occasioned by war-time shortages of personnel and equipment. The gardens and trial grounds of the Plant Breeding Station at Penglais, with the larger plots and field trials at Frongoch and the multiplication fields at Morfa Mawr, provided the background for a spectacular display by Prof. T. J. Jenkin and his colleagues of the use and application of the old and new methods—to the envy of the animal breeders, who, restricted by the numerical smallness, but physical largeness, of their material, have also to think in terms of populations.

The years of war have accelerated the spread of the selected Aberystwyth strains of grasses and of clovers into practical conditions of grassland establishment. The urge to increased production of British agriculture has given encouragement to ley farming, and the demand for seed of known origin has had repercussions in the seed trade, as well as on the administrative and routine activities of the staff of the Station. At the same time, the principles and methods of improving the swards of the higher and inherently poorer grazing lands, as developed at Llety-Evan-Hen and the Cahn Hill Improvement Scheme, have been given a wider extension to other hill areas, to the enhancement of stock production, as was described by Mr. Moses Griffith and Prof. W. Ellison at the separate meeting of the Society of Animal Production. The prospect of the early discontinuation of the Cahn Hill work is regarded with concern by both Societies, the members of which recognize the important role of the hill farming areas in the maintenance of a healthy and balanced stock-raising industry in Great Britain.

Though somewhat envious of the technical opportunities and material advantages offered to the plant breeders, the stock men were none the less comforted. They found themselves, for example, on familiar though not so clearly signposted country in noting such matters as the variation among the progeny from selected parents and strains, the differential responses of varieties and strains under a common environment and changed behaviour in other environments, the range in maturity, the effects of length of day on reproductive organs, the handiness of 'indicator' characters (but not of necessity their feasibility as measures of performance), change or 'degeneration' in the later generations of stocks grown on in other areas, or even the different potentialities and performances of 'pedigree' and 'commercial' strains. There should be much common ground here for future co-operation in study and discovery of principles, for example, in wedding the ecological approach to the genetical, to enlighten the limits of selection in one environment to meet the demands and suitabilities in another.

The present divergence of views occurs with regard to purpose and method. The emphasis in the grassland work appears, to the animal husbandman, to be on the sward, and its management to the benefit of the sward. The increased productivity of swards, as swards, which can emerge from suitable seeds mixtures, sown under favourable conditions of soils and cultivations, with appropriate fertilizer treatments and apt grazing and cutting, is clearly demonstrable and has, in fact, been often and well demonstrated.

The possible marked extension of the grazing season and the expanded opportunities for conservation of the surplus product of highly valuable protein foodstuff affords hope of a greatly enhanced, even revolutionary, level of animal production. Sir George Stapledon, in a noteworthy address, suggested a ten-year plan for more livestock to utilize his envisaged 9 million acres of leys and 4 million acres of permanent grass against the present 10 million permanent and 3 million leys—and asked for guidance as to numbers, kinds and quality for this target. Yet he, adding his emphasis to that offered by many of the demonstrations, recognizes the extraordinary niceties of reaction of the plant strains and mixtures to all points of management, and implied doubts whether a suitable technique of testing the absolute value of the pastures can be derived unless they are grazed at different intensities of grazing, and admitted that at times, for suitable conditions of conservation of surplus growth, drastic treatment by cutting has to be adopted.

The main use of grassland is for grazing—but that platitude over-simplifies many of the real issues. Experimentally it may justify using the grazing animal to measure pasture productivity in terms of live-weight increase or milk yield, which terms achieve an apparent validity since they are involved in economic or practical returns. However, it has also been clearly shown that grazing in itself is a powerful factor in altering the composition and 'utility' of the grazed pastures. Pasture management has long been realized to involve control of the biotic factor, but from the animal physiologist's point of view the nature of this complex influence is by no means sufficiently understood for it to be used as anything more than a very general and indirect measure of productivity. This is especially the case when there is a dearth of experimental evidence on the important question as to how far the very conditions of restraint, implied in using animals to graze small plots under trial conditions, themselves affect the animals' reactions, behaviour, growth, development and output, as of live-weight.

The ultimate purpose is to translate experimental results into farm practice. This introduces another set of, as yet, imponderable factors. The field is a unit only in so far as it is part of the farm; the grazing animal also is part of a herd or flock. For the farm as a whole—even for the country as a whole—the supply of winter feed is the limit to production; to widen this restriction, forage crops and conserved grassland in the form of silage or dried grass offer prospects of greater development. But a better and more efficient alternative in present circumstances, in Dr. John Hammond's view, might be to utilize the high production of the summer months for cheaper summer fattening, and to conserve and store the animal product rather than the grass. Again, the numbers of animals on a farm are relatively fixed over long periods; under practical conditions, especially in these days of self-contained dairy herds, the farmer cannot arrange the timing or intensity of grazing to meet those niceties of management which the grassland expert dictates as optima for the good of the sward. As Prof. W. C. Miller suggested, the complex situation of stocking and stock-management may require more complex mixtures of grazing constituents to provide pastures which can be practically mismanaged with safety, rather than a multiplicity of mixtures and treatments, each needing specific control to evoke their best response.

So long as conditions vary from farm to farm, field to field, and season to season, the principles of stock and grazing management must be allowed very flexible application. Even those of rotational grazing, with subdivision of the areas into smaller units, particularly in so far as it involves the human factor of judgment of pasture productivity, are not fully understood, as the plots at the College Farm at Nantcellan show. The formal and informal discussions at these meetings proved that a great deal of endeavour remains to be applied to the problems of the pastures we grow, the uses to which they can be put, and our methods of using them—and that any mutually exclusive interpretation of the results of experiment and observation by animal and grassland specialists is no longer admissible.

J. E. NICHOLS

THE RADIATIONS FROM THE EARTH'S ATMOSPHERE

IN the latitudes of London, Paris or Washington the appearance of an aurora borealis is somewhat infrequent and finds few investigators prepared with equipment for detailed observation. Most of the work on the location and spectra of aurora has therefore been done at such places as Tromsø, which are within the main auroral belt: our knowledge of the phenomenon is mainly due to Størmer and Vegard, and their collaborators. The principal progress has been achieved in the present century, and especially in the last ten or fifteen years. It has only been rendered possible by the rapid general advances in physical techniques and equipment.

During the first quarter of this century, it began to be recognized that at all latitudes the night sky is appreciably luminous even in the absence of the moon. This effect is partly due to radiation from the stars, both those individually visible and those much more numerous stars too faint to be detected by the unaided vision; the zodiacal light, which is of the nature of scattered sunlight, also makes a contribution. But the major part of the luminescence originates in the atmosphere itself: its spectrum shows a complex set of emission lines and bands against a continuous background. The intensity is very low, so the observational work is extremely difficult. Slipher, who was among the first to study the spectrum of the night sky light, discovered that a permanent component of it is the famous green line previously known to be prominent in the auroral spectra. Rayleigh, who used characteristically simple methods, devised and carried out, partly with the aid of observers overseas, a many-sided programme of observations. By means of filters he distinguished three different spectral regions and studied their geographical distribution and their temporal variations. He even measured the absolute intensity of the green line: the number of photons he found to be emitted in a square centimetre column of atmosphere is about 2×10^8 per sec. This remarkable pioneer work gave results of lasting value.

The problem of the identification of the green line was solved by McLennan and his colleagues who, in the years 1925–27, showed that it arose from atomic oxygen and is due to what is called a forbidden transition—that is, one that violates the normal selection rules and is only possible because of their approximate nature. Now the emission of the green-line radiation does not bring the oxygen atoms involved to their ground-state; it instead brings them to the lowest excited state. In final passage from this state, radiation may be emitted corresponding to certain red lines. These have now been found both in the night sky and auroral spectra. It is possible that the forbidden lines of atomic nitrogen are also present.

More recently, in 1938, there came from France the astonishing news that sodium occurs in the high atmosphere in the free atomic form. Proof for this was provided by the identification of its characteristic yellow line (or rather doublet).

In addition to the atomic lines a large number of bands appear. Those in the spectra of auroras can be ascribed mainly to neutral and singly ionized molecular nitrogen. Much work has yet to be done on the interpretation of the night sky spectrum; but it seems probable that the principal contribution to the visible region is from neutral molecular nitrogen, and the principal contribution to the ultra-violet region is from neutral molecular oxygen: the bands of singly ionized molecular nitrogen seem to be normally absent. An interesting discovery, made in 1942 by Herman, Herman and Gauzit, is a remarkably strong emission in the infra-red region: its identification is still in doubt.

A growing number of highly skilled observers have been drawn into this branch of research and have obtained many unexpected and varied results. These have aroused the interest of geophysicists, astrophysicists, laboratory spectroscopists, theoretical physicists, radio scientists, chemists, and mathematicians. One manifestation of this interest was an international conference on the "Emission Spectra of the Night Sky and Auroras" organised under the auspices of the Gassiot Committee of the Royal Society and held in the Society's rooms at Burlington House, London, during July 7–10.

The Gassiot Committee is charged with the supervision and planning of a long-term programme of research on the radiation in the atmosphere and on related phenomena. This commitment was undertaken at the request of the Air Ministry (on the advice of the Meteorological Research Committee). Financial aid is given by the Ministry. The initiative in proposing the conference was taken by Prof. H. S. W. Massey, chairman of one of the sub-committees appointed by the Gassiot Committee to deal with different sections of the general programme.

The conference was attended by guests from Belgium, France, Norway, Sweden and the United States, and by many from the British Isles. Russian scientific workers have done much work in the field concerned, but none was able to be present: the Embassy, however, sent an observer. The papers read at the conference will be published by the Physical Society in the next issue of its "Report on Progress in Physics". Here only an outline of the ground covered will be attempted.

The best recent observations of the night sky spectrum have been made in France and the United States. Papers describing the results were contributed by G. Dejardin, J. Dufay, Tcheng Mao-Lin, A. and E. Vassy, R. Grandmontagne, C. T. Elvey and E. O. Hulburt. There was considerable discussion of the altitude of the luminous region, which is still very uncertain. Much attention was given to the special character of the spectrum at twilight, when the negative bands of nitrogen, the red lines of oxygen, the yellow doublet of sodium and possibly other components are enhanced. A. Kastler described work by J. Bricard and himself on the polarization of the light of various atomic lines using a very simple polariscope due to Savart and improved by Lyot. The green oxygen line was found to show less than 3 per cent polarization—a result to be expected from theory, but contradicted by recent measurements in the U.S.S.R. D. Barbier, R. W. B. Pearse and others discussed the identification of the spectral components. A great deal of time was devoted to the complex and fascinating task of explaining the cause of the emission. D. R. Bates, H. S. W. Massey, and M. Nicolet contributed papers relating to this problem. It seems probable that the emission is due in part to the dispersion of the energy stored up by the dissociated oxygen (and perhaps also nitrogen) formed during the day: recombination of the charged particles in the ionosphere will play a minor part. Consideration has also to be given to the suggestion that incident particles may have to be invoked to explain such effects as the irregularity of the light. Much remains to be elucidated. P. M. S. Blackett presented an interesting paper on the possibility of cosmic rays making an observable contribution to the continuum through Cerenkov radiation.

Recent observational work on auroras was reported by G. Kvifte (on behalf of L. Vegard) and by R. Bernard. Confirmation was given to the suggestion that hydrogen and helium may be present. An important new analysis of the spectrum was given by M. Nicolet. K. G. Emeléus read a paper sent by J. Kaplan describing laboratory experiments on the reproduction of the characteristic emissions.

It is generally accepted that auroras are due to the action (direct or indirect) of charged particles guided pole-wards by the earth's magnetic field. However, the nature, origin and energy of these is still the subject of controversy. Widely different views were expounded in papers by H. Alfvén, S. Chapman, and F. Hoyle.

One session of the conference was devoted to a discussion, led by R. W. Ditchburn, on the instruments and techniques of observation. E. O. Hulburt gave a valuable account of the work being done in the United States on the exploration of the upper atmosphere by means of rockets.

S. CHAPMAN
D. R. BATES

OBITUARY

Prof. J. Perner

THE death occurred at Prague, on June 9, of Dr. Jaroslav Perner, professor of palæontology at the Charles University. Born at Tynec-nad-Labem on March 28, 1869, Perner claimed to be a pupil of the French geologist, Joachim Barrande (1799–1883), in whose footsteps he followed by continuing the investigation of the fossil fauna of the Silurian and Devonian rocks of middle Bohemia. His studies were incorporated in various publications, including "Système silurien du centre de la Bohême" and a work of four volumes entitled "Études sur les graptolites de Bohême". Most of his other publications were in Czech or German.

Early in life Perner came to England and spent a period in the 'nineties at Mason College (afterwards the University of Birmingham) working under the late Prof. Charles Lapworth. J. G. F. D.

NEWS and VIEWS

The Royal Society of Arts

H.R.H. THE PRINCESS ELIZABETH has graciously accepted the invitation of the Royal Society of Arts to become its president. The Royal Family has been closely connected with the Royal Society of Arts for more than a hundred years. Prince Albert became the Society's president in 1843, and in that capacity initiated the Great International Exhibition held in Hyde Park in 1851. Other Royal presidents have been Their Royal Highnesses the Prince of Wales (later King Edward VII), the Prince of Wales (later King George V) and the Duke of Connaught.

The British Museum (Natural History)

Sir Clive Forster-Cooper, F.R.S.

SIR CLIVE FORSTER-COOPER will retire from the post of director of the British Museum (Natural History) on September 30, after ten arduous years of office, and a much longer period spent in the service of museums and libraries. His active interest in museum problems goes back to the days when, as a young man, he studied in the American Museum of Natural History under the late Prof. H. F. Osborn; but he was not connected with a museum in an official capacity until some years later. In 1914 he became superintendent of the University Museum of Zoology, Cambridge, and immediately began a much-needed reorganisation. By dint of drastic pruning and rearrangement, he transformed an old-fashioned teaching collection into a modern museum well adapted to the changed conditions after the First World War. During this period, Mr. Forster-Cooper was elected a syndic of the FitzWilliam Museum, and also to the University Building Syndicate of which he ultimately became chairman. The scheme for a new university library had its origin in a suggestion which he made soon after his election to the latter body.

When the Principal Trustees appointed him director of the Natural History Museum in 1938 he began to replan the exhibition galleries, and here his long experience in Cambridge was of great value. For the first year all went well, and important experiments in exhibition technique were carried out; but the international situation gradually became more threatening, and early in 1939 all these plans had to give way to others for the evacuation of the collections and libraries, and to general precautionary work. These tasks were scarcely finished when air raids on London began. In quick succession the roofs were burnt off the Herbarium and the Shell Gallery, and further damage was done to the building by high-explosive bombs. All the time that the Director was dealing with the day-to-day hazards of war, he was laying his plans for the future. They were summarized in a memorandum which was adopted by the Trustees as a basis for future action, although any hopes of their immediate realization were dashed when a flying bomb, which exploded in the Cromwell Road in July 1944, wrecked almost the whole of the interior fittings in the front galleries of the Departments of Geology and Zoology. After the War he supervised the return of the libraries and collections, and the reopening of those parts of the ground-floor of the Museum still fit for use. His services received official recognition with the award of a knighthood in the New Year Honours of 1946.

Mr. N. B. Kinnear

MR. NORMAN BOYD KINNEAR, who has been appointed to succeed Sir Clive Forster-Cooper as from October 1, was educated at Edinburgh Academy and Trinity College, Glenalmond. After acting for two years as an assistant, on a voluntary basis, in the Royal Scottish Museum, he became for twelve years curator of the Bombay Natural History Museum and from 1908 until 1919 was assistant editor of the important Bombay Natural History Society's *Journal*. In 1920 he joined the staff of the British Museum as an assistant keeper, and after a period as deputy keeper was, in 1945, appointed to the keepership of the Department of Zoology.

Mr. Kinnear's time in India gave him the opportunity of much work in the field and of acquiring a wide knowledge as a field naturalist of the living fauna of the country in general in addition to his main line of work as an ornithologist. Most of his published work, chiefly in the *Ibis* and the *Journal of the Bombay Natural History Society*, deals with birds, especially the avifauna of the East, as, for example, the birds of the Eastern Ghats, of central south Arabia, Chinese Turkestan, north-east Burma, and south-east Tibet among others.

During the War, in addition to the struggle of keeping the Department of Zoology going under very adverse circumstances, he did signal service first in helping with the evacuation of the Museum's collections to safer places than London and then, after the War, in the complicated business of their return, unpacking and resettlement, work which is still in progress and in present circumstances requires much thought and planning. Mr. Kinnear in 1943 was elected president of the British Ornithologists' Union and is the present chairman of the British Section of the International Committee for Bird Protection.

Science in Scotland

UNDER the title "Science in Scotland", Dr. W. P. H. Wightman gives a very readable account of the development and work of the Rowett Research Institute in Animal Nutrition, the Macaulay Institute for Soil Research, the Moredun Institute of the Animal Diseases Research Association, the Institute of Animal Genetics, the Hannah Dairy Research Institute, the Torry Research Station for fishery research and the Scottish Society for Research in Plant Breeding ("Science in Scotland: the Work of the Scottish Research Institutions", by Dr. W. P. H. Wightman. Published for Scottish Convention. Pp. 56. Stirling: Eneas Mackay, 1947. 2*s*. net). Some of the achievements of these research institutions are indicated, while in a final chapter the foundation of the Seaweed Research Association is noted and the establishment of a Scottish Forest Products Research Station and of a Sea Loch Development Association is suggested. Dr. Wightman is not convinced as to the advisability of separate Scottish institutions for most manufacturing traditional industries, and suggests that the principles guiding the establishment of distinctive Scottish research institutions should be in the main the development of predominant Scottish resources; the special problems arising out of Scottish customs and conditions; the need for economy in time for consultation even at the cost of duplicating overhead charges; and the appeal to national enthusiasm and local interest.

Education in the Royal Air Force

The Secretary of State for Air has announced that the Air Council has decided to set up an Educational Advisory Council for the Royal Air Force with the following terms of reference: "To keep under review the educational policy for the Royal Air Force and to advise the Secretary of State for Air on such matters connected with education in the Royal Air Force as they think fit and upon any educational questions referred to them by him." The following will, in addition to representatives of the Ministry of Education, the Scottish Education Department, and the Ministry of Labour and National Service, serve on the Council: Dr. Keith A. H. Murray, rector, Lincoln College, Oxford (*chairman*); Mr. Harold E. Clay, president, Workers' Educational Association; Miss M. C. Glasgow, secretary-general, Arts Council of Great Britain; Mr. Ronald Gould, general secretary, National Union of Teachers; Miss V. Holmes, member of the Council of the Women's Employment Federation; Mr. J. C. Jones, director of education, the Polytechnic, Regent Street, London; Air Chief Marshal Sir Edgar Ludlow-Hewitt, R.A.F. (retired); Mr. H. Morris, chief education officer, Cambridgeshire; Mr. J. H. Nicholson, principal, University College, Hull; Dr. D. R. Pye, provost, University College, London; Mr. W. E. Williams, director, Bureau of Current Affairs; Mr. J. F. Wolfenden, headmaster, Shrewsbury School.

Science in the New India

The presidential address of D. N. Wadia at the thirteenth annual general meeting of the National Institute of Sciences of India, after referring to the ten-acre site which the Institute has acquired for its building and to the organisation and expansion of its secretariat and mentioning the formation of two strong committees to advise the Government on research in the Indian academies, institutes and universities, was devoted to a discussion of the role of science in building the new India. Science, in its comprehensive application to problems of human existence, is the one agency which, in the transition period through which India is passing, will lift the country out of its abnormal economic and industrial depression and put it on the high road to progress and human welfare. The first requisite is that India should align her scientific organisation with that of the progressive countries of the world, and Mr. Wadia welcomed the multiplying ties of India's leading men of science with representative men of science of Great Britain, the United States, the U.S.S.R. and the rest of Europe, referring in particular to the value of the United Nations Educational, Scientific and Cultural Organisation, of the international scientific liaison offices, and to the work of the Royal Society Empire Scientific Conference and of the Commonwealth Scientific Official Conference.

Discussing India's response to the latter Conference, he insisted that the unhealthy distinction between official and unofficial scientific workers must go, and that the universities, private research institutions and societies will more and more be the spearheads of scientific progress. Striking progress has been made in the last few years in irrigation and hydraulic research, and the Government during the last year has sanctioned large-scale operations on several hydro-electric power, irrigation and reservoir projects, giving high priority to three large projects connected with the harnessing of the Damodar, the Mahanadi, and the Kosi Rivers. A committee formed under the Board of Scientific and Industrial Research has drawn up a long-range programme of research in nuclear physics and artificial creation of atomic particles to be carried out at the Tata Institute of Fundamental Research and at the Palit Laboratory, University of Calcutta. In regard to minerals, the Government is taking steps to bring under Federal control those of strategic importance and was convening a Conference to formulate a mineral policy for India and to establish executive machinery for guiding production, conservation and utilization of the mineral products mined.

Winchester City Museums, 1847–1947

July 15 of this year marked the centenary of the Winchester City Museum, and the curator, Mr. Frank Cottrill, has appropriately marked the occasion with a short account of its history and growth. Established in 1847 as the Hampshire Museum, this institution set out to save for posterity collections illustrative of local history, antiquities and natural history which might otherwise have been "lost or disregarded, retained in private hands, or have found their way to distant exhibitions". For a time the Hampshire Museum flourished on private donations and subscriptions, but later, as has been the case in so many of the local museums founded during or near the same period, this form of support was not maintained. The nature of the collections, however, and the increased use of the Museum by the public, fully justified the upkeep of the institution. Accordingly, in 1851 it was transferred to the custody of the Winchester Town Council, under the government of which it remains at the present time. A Museum Committee was appointed, and the institution from then on became known as the City Museum. In this way was the safety of the Winchester collections safeguarded. Originally housed in the Hyde Abbey schoolroom, the collections were removed first to part of the old jail in Jewry Street, then to the top floor of the Guildhall, and finally, in 1903, to the present building in the Square. Prior to that, in 1898, the Museum was extended by the opening of the Westgate as a second museum. This was largely due to the interest and beneficence of Alderman W. H. Jacob, a keen local historian. A beautiful old building dating from the thirteenth century, but unfortunately overshadowed by modern constructions entirely out of keeping, Westgate to-day houses, among other things, the City's famous collection of weights and measures ranging in date from the twelfth to the eighteenth centuries. Here, also, is preserved the Winchester moot-horn of about A.D. 1200.

Mr. Cottrill's proposals for the reorganisation of the Collections concern mainly the very overcrowded City Museum, and he rightly stresses the need for the relegation to store of much of this material if the Museum is to illustrate effectively and teach the early history and subsequent development of the town and county. (Storage in this connexion does not mean that collections will become inaccessible to students and others specifically interested in them.) There is an ever-growing tendency for the smaller museums to specialize in the interests of their own particular region, and this, without doubt, is the only way in which the majority of them can become effective units in the community they serve. The curator of the Winchester Museums clearly wishes for development along similar lines, and if his plans are adopted the Winchester collections, already well known to students at home, should attract to "the capital city of Alfred and Canute" visitors from farther afield. In the reorganised Museum, he also points out the need for a printed guide and the maintenance of a small reference library. These are matters which are often overlooked by an authority responsible for an otherwise good museum service.

Diseases of Flax

In February 1943 the Minister of Agriculture (Eire) set up a Flax Development Board for the purpose of encouraging flax production. Owing to the stimulus of better prices and a guaranteed market for flax under war-time conditions, the area cropped in 1942 had already risen to 18,552 acres compared with only 4,123 acres in 1939. The Board's activities resulted in a further sharp rise in area under flax, the peak being reached in 1945 when just over 32,800 acres were grown. Such intensive cultivation inevitably introduced fresh problems, and diseases and pests became more prevalent and assumed greater significance. At the request of the Board, Dr. R. McKay has prepared a bulletin, "Flax Diseases" (price 5*s*.), which will meet a long-felt want. Though the information contained in this publication does not claim to be new, it has hitherto been so scattered in various scientific and agricultural journals as to be quite inaccessible to the ordinary farmer, flax inspector or mill-owner. The diseases are grouped according to the causative factor, whether it be fungus, parasitic flowering plant or non-parasitic agent, such as weather conditions. Insect pests are also included. The symptoms are clearly described and illustrated in each case and control measures suggested where possible. References are supplied for those who wish for more detailed information, and a useful glossary of scientific terms included.

Pacific Science

The University of Hawaii has long been an active centre for scientific investigations in the Islands, as has the Bishop Museum, Honolulu. This work will now be intensified as the result of the wise co-ordinating policy laid down by the National Research Council of the Pacific Science Conference at its meeting in Washington in June 1946. Partly as a result of this, the University has undertaken to sponsor a new quarterly journal, entitled *Pacific Science*, which is devoted to the furtherance of biological and physical sciences in the Pacific region. Two numbers of this publication, those for January and April, are now to hand and they are excellently printed, illustrated and produced. The personnel of the editorial board covers a wide range of subjects and, interestingly enough, the editor-in-chief is the head of the Department of English.

Each number consists of sixty-eight pages, very similar in size to *Nature*, and is provided with an attractive coloured cover on the inside of which are useful instructions to authors for the preparation of papers. The two numbers include papers on forestry, geology, ornithology, parasitology, mycology, botany, an apparatus for chloride and oxygen determination for pond waters in the field, and the Tsunami, that long-period gravity wave associated with volcanic disturbance, one of which in April 1946 created such havoc in the Islands. No. 1 contains, as a sort of appendix, the interesting recommendations of the National Research Council referred to above, and No. 2 similarly reviews the facilities for research in the Islands provided by more than twenty government or private institutions. The subscription to *Pacific Science* is 3.00 dollars per annum, payable to the Office of Publications, University of Hawaii, Honolulu 10, Hawaii. With the extraordinary wealth of material available not only in the Islands themselves but also in the rest of the Pacific group which will be included in its scope, the journal should have an assured future, and we wish it every success.

Royal Commission for the Exhibition of 1851

The report of the Board of Management, Royal Commission for the Exhibition of 1851, dated December 1946, covers the seven years since July 25, 1939 (from the Commission, 1 Lowther Gardens, London, S.W.7). The award of industrial bursaries was discontinued on the outbreak of war, and in July 1946 only seven of the twenty-nine bursars appointed in 1939 and none of those appointed earlier remained on the books. While the Board has already given 'rehabilitation' grants to a few bursars who wished to complete their industrial training and who have been unable to obtain assistance for this purpose under the regulations of the Ministry of Labour and National Service, the Board has resolved to suspend the scheme for the present and to re-examine the position when industry in Great Britain and its pattern of recruitment have acquired a more definite pattern. The Board has, however, increased to £500 a year the value of the post-graduate scholarship in naval architecture, and new regulations have been prepared which will open the field to candidates from all university institutions in the United Kingdom which have departments of naval architecture or engineering science. The scholarship will be tenable normally for two years, and the conditions have been designed to make it attractive to the trained research worker. Arrangements have also been made for the partial resumption of the activities of the British School at Rome, and discussions on the re-development plan for the South Kensington estate have been renewed. Certain modifications in the plan have become necessary in view of the urgent importance of extending the Fuel Technology Laboratory already on the site to the west of the Royal College of Music, and which the Imperial College of Science and Technology had originally proposed to relinquish.

The Board of Management also endorses the views expressed by the Science Scholarships Committee in a separate report covering the proceedings of the Committee since April 1939. The Committee, reviewing the working of the Science Research Scholarships Scheme between the two Wars, agrees that no major change is needed in the general principle of the overseas scheme, but recommends that the value of the scholarships should be increased to £350 a year with a £50 annual grant for fees, and that a second annual scholarship should be allocated to India. On the other hand, it recommends that the value of the senior studentships should be increased to £500 a year with a possible extra £50 for expenses, but that the number of annual awards should be reduced from five to four. The additional expense of giving effect to these recommendations is estimated at rather more than £3,000 a year. Particulars are included in the report of the appointments made for 1946 in accordance with these recommendations; although normally only ten overseas scholarships are awarded, an additional scholarship has this year been granted to New Zealand in view of the exceptional merits of the two candidates put forward.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Decay of Negative Mesons in Matter

A VERY drastic change in the present conception of the interaction of mesons with atomic nuclei was suggested by Fermi, Teller and Weisskopf[1] as a result of the experiments by Conversi, Pancini and Piccioni[2], who observed the behaviour of positive and of negative cosmic ray mesons coming to rest in iron or graphite. They find that in iron, disintegration electrons are observed only for positive mesons. According to Tomonaga and Araki[3], this is to be expected because negative mesons—in contrast to positive ones—after being slowed down can approach the nucleus and be absorbed by it in view of the strong interaction postulated by Yukawa to explain nuclear forces. In graphite, on the other hand, decay electrons were observed from both positive and negative mesons. Fermi *et al.* concluded that this was in sharp disagreement with expectation, because according to their estimate it takes only about 10^{-12} sec. until a negative meson in a solid reaches its lowest orbit, from which it should be captured by the nucleus in less than 10^{-18} sec. Since the natural decay time is only 10^{-6} sec., they conclude that from negative mesons no decay electrons should be expected, in contrast to the experimental evidence in graphite.

To calculate the slowing down of mesons with an energy below 2,000 eV. (that is, with smaller velocity than that of the electrons of the solid) these authors use a Fermi gas of free electrons as a model of the solid. I wish to point out that, for non-conductors in any event, this model does not seem to be adequate, and that a better model might be obtained in this case by using an assembly of electronic oscillators as a model of the solid. That this model leads to results entirely different from the free-electron model follows from the fact that a point charge e moving with constant velocity v transfers energy proportional to v^2 to free electrons, but proportional to exp $(-a\omega/v)$ to an oscillator (frequency $\omega/2\pi$, closest approach a) if $a\omega \gg v$. In this connexion a result obtained by Pelzer and me[4] may be of interest. A point charge moving with constant velocity v through a dielectric with dielectric constant ε having a proper frequency $\omega/2\pi$ transfers to it energy at a rate

$$\frac{\varepsilon - 1}{\varepsilon}\,\frac{e^2}{a_0}\,\omega\gamma e^{-2\gamma}, \text{ approximately,}$$

if $\gamma = a_0\omega/v \gg 1$. Here a_0 is of the order of the zero-point amplitude of the oscillators of which the dielectric is composed. Taking $e^2/a_0 = 10$ eV., $\omega = 10^{16}$ sec.$^{-1}$, $(\varepsilon - 1)/\varepsilon \simeq 1$, and $\gamma = 15\ (13)$ (= ratio of velocities of electrons and mesons of equal energy) yields a rate of loss of only 10^5 (10^7) eV. per sec.

No doubt this crude method of calculation requires considerable improvement to obtain quantitative results. It serves, however, to show (i) that the model of oscillators leads to times of slowing-down which are larger by many orders of magnitude than those of a free-electron model, and (ii) that the rate of loss of energy is a quantity which (in view of the exponential factor) is very sensitive towards variation of $a\omega/v$ and may lead to slowing-down times just above or below the decay time of mesons. It seems possible that even in metals a modification of the method used by Fermi *et al.* might be necessary, taking account of the screening of the charge of the moving meson.

Therefore it seems that the drastic change suggested by Fermi, Teller and Weisskopf[1] need not be contemplated at present, but that very detailed calculations will be required to make predictions about the slowing-down time of mesons.

I wish to express my thanks to my colleagues of this Laboratory for interesting discussions.

H. FRÖHLICH

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June 23.

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[1] Fermi, Teller and Weisskopf, *Phys. Rev.*, 71, 314 (1947).

[2] Conversi, Pancini and Piccioni, *Phys. Rev.*, 71, 209 (1947).

[3] Tomonaga and Araki, *Phys. Rev.*, 58, 90 (1940).

[4] Fröhlich and Pelzer, E.R.A. Report, to be published.

Definition of Nuclear Quadrupole Moments

THE quadrupole moment of a nucleus is usually defined[1] as "the quantity $(3z^2 - r^2)_{Av}$, where the average is taken over the nuclear charges for the state which has the maximum component of spin I in the z direction". This seems to imply that the average is taken over all the protons in the nucleus; but if this be so, it is impossible to reconcile the measured values of nuclear quadrupole moments quoted by Mattauch[2] with current ideas of nuclear size. Thus the quadrupole moment of tantalum is reported to be 6×10^{-24} cm.^{2}, which seems incompatible with a nuclear radius of about 9×10^{-13} cm. It seemed desirable, therefore, to examine carefully the derivation of the measured values.

All the quadrupole moments so far measured have been determined spectroscopically by analysing the deviation of the hyperfine structure from the interval rule. In all cases the calculation has depended ultimately on the theoretical work of Casimir[3]. Reference to Casimir's essay reveals that he defines the quadrupole moment as $Q = \int\rho(3z^2 - r^2)d\tau$, where ρe is the charge density of a volume element $d\tau$ and the integral is taken over the whole of the nucleus. Casimir calls this an average and writes it $\overline{(3z^2 - r^2)}$; but the use of the term 'average' in this context appears to have caused some confusion, for the following reason. If the quadrupole moment is regarded as due to a single proton, the remaining protons being assumed to have a spherically symmetrical distribution and therefore contributing nothing to the integral, then Q as so defined is the average value of $(3z^2 - r^2)$ for that proton. On the other hand, if each proton in the nucleus is regarded as contributing to the quadrupole moment, then the average value of $(3z^2 - r^2)$ over all protons is Q/Z, where Z is the total number of protons. Thus each of the quantities Q and Q/Z can, with some justification, be called an 'average' of $(3z^2 - r^2)$, depending on the system over which the average is taken. If one bears in mind that the quantities which have been measured experimentally are the values of Q, and not of Q/Z, they are seen to be of the expected order of magnitude.

It should be pointed out that whereas most writers on the subject adopt Casimir's convention in calling Q the 'average', this is not universally so. For example, Feather[4] explicitly defines the quadrupole moment (which he denotes by q) as the average over all protons, and in support of his definition states that the quadrupole field is proportional to Zq. However, the experimental values which he quotes are values of Q, so that these should be divided by Z to conform to his definition.

E. H. RHODERICK

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May 30.

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[1] See, for example, Kellogg, Rabi, Ramsey and Zacharias, *Phys. Rev.*, 57, 677 (1940).

[2] Mattauch, "Kernphysikalische Tabellen" (Springer, 1942).

[3] Casimir, "On the Interaction between Atomic Nuclei and Electrons". Prize essay published by Teyler's Tweede Genootschap. Also published in *Archives du Musée Teyler*, iii, 8, 201 (1936).

[4] Feather, "Nuclear Physics" (Cambridge, 1936), 109.

Probabilities of Magnetization

IN an earlier analysis of the B—H curves of polycrystalline iron it was shown that a simple 'trichotomy' of the steep part of the curves could lead to useful estimates of the quantitative distribution of operative lattice orientation along any given direction in polycrystalline sheet material[1]. Subsequent work was directed towards correlating such estimates with directional measurements of Young's modulus[2]; and it has been found that while the general trend of agreement is unmistakable, there is a consistent tendency for the trichotometrical method, when applied along the rolling direction, to yield a modest over-assessment of the operative percentage of [100] orientation.

The most likely causes of a systematic discrepancy of this kind would appear to be: (1) that there is a deficiency in the previously adopted conventional assumption that in the demagnetized state there will exist an equivolumetric distribution of domain magnetization along each of the six possible [100] crystal directions of easy magnetization; and (2) that the original approximation made no provision for the inevitable overlapping between the 'easy' reversals in one crystal-group and the 'hard' reversals in another.

An attempt has therefore been made to arrive at a sounder physical basis for the concept of trichotomy, and at the same time to gain further insight into the actual build-up of the technical magnetization curve, by postulating that the 180° reversal component of the steep part of the curve (for polycrystalline iron) will represent the summation of three probability-integrals, one for each of the idealized [100], [110] and [111] crystal-groups; and that each of these three integrals will satisfy a relationship of the form

$$\mu_d = \mu_{dm} \, . \exp\left[-b\left\{1 - (H/H_m)\right\}^2\right], \quad . \quad (1)$$

where μ_d is the differential permeability; μ_{dm} is the maximum value of μ_d; and b is a 'variance' factor or a 'distribution index' which will reflect, for any given crystal-group, the manner in which the achievement of 180° reversals is distributed about some characteristic 'mode' H_m of the critical field strength.

This revised treatment will clearly lead to a general relationship of the form

$$B = \mu_n H + \Sigma\mu_{dm} \int_0^{H \leqslant 2H_m} \exp\left[-b\left\{1 - (H/H_m)\right\}^2\right] dH, \quad (2)$$

where B is the externally measured magnetic induction, and μ_n is of the same order as the initial permeability μ_0. For iron and iron-silicon alloys, the summation term will comprise the areas generated by equation (1) for each of the three idealized crystal-groups. In equation (2), the $\mu_n H$ term will ordinarily be relatively small.

Investigation along these lines has indicated that this method of synthesis can lead to consistently improved and close agreement with observation up to the 'knee' region of the magnetization curve, that is, up to the point at which 180°-reversals are expected to be substantially completed[1]. A detailed discussion of its apparent applicability to a variety of experimentally induced conditions is in course of preparation for later publication, and the present communication is being submitted because the general picture which presents itself seems to provide an explanatory background for the peculiarly 'peaked' K_d curves recently recorded on certain types of ferromagnetic wire[3]. It will readily be seen that the summation term of equation (2) is fully competent to take charge of sharply segregated inhomogeneities of magnetization such as would result from the existence of markedly differing 'phases' in a ferromagnetic specimen; each phase will be expected to behave in accordance with its own 'probabilities', with resultant irregularities in the observed K_d curve. It is also clear that the physical basis of the treatment is in complete harmony with the expressed view that the irregularities observed "represent 180° reversals of demagnetized domain orientation of magnetization at values of H corresponding to the critical value of H_0 for different ferritic combinations."[3]

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May 24.

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[1] Richer, *J. Iron and Steel Inst.*, 150, 111 (1944).

[2] Richer, *Metallurgia*, 33, 251 (1946).

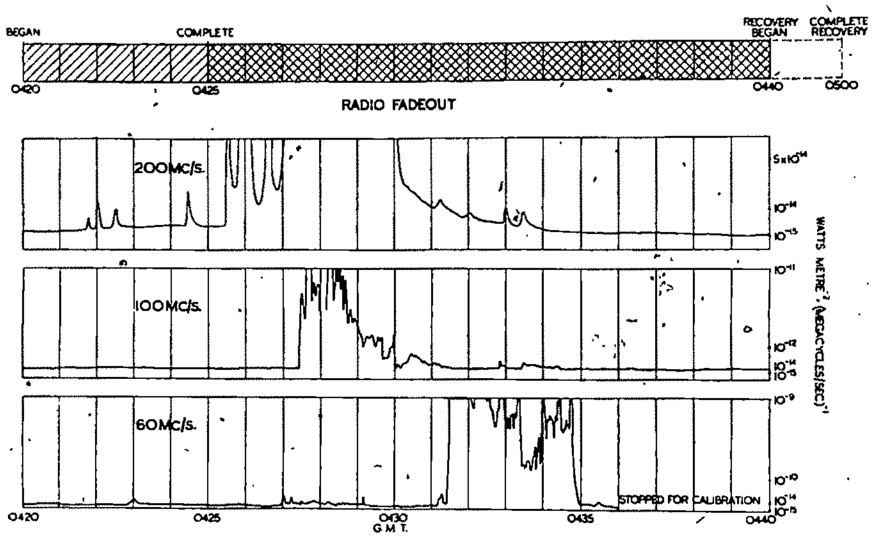
[3] Hobson, *Nature*, 159, 436 (1947).

Relative Times of Arrival of Bursts of Solar Noise on Different Radio Frequencies

IT is becoming recognized that on metre wavelengths solar noise from the disturbed sun is characterized by the occurrence of sudden large increases in intensity of a duration of several seconds or minutes. Bowen[1], of this Laboratory, has reported that these increases of intensity are not necessarily coincident in time or shape when observed on different radio frequencies. The present communication describes observations, chiefly during July and August 1946, of the relative times of arrival of such bursts on 200, 75 and 60 Mc./s., with a few observations on 30 Mc./s. For each frequency a separate receiving system, actuating its own recording meter, was used. Loud-speakers were also connected giving aural confirmation of the recorded data.

Three main conclusions can be drawn from these observations:

1. *Lack of correlation between most bursts.* First and most important, the majority of the intensity variations, particularly the smaller ones, show no correlation with those on other frequencies. This supports a hypothesis that the noise on different



Large outburst of March 8, 1947

frequencies normally originates in widely separated levels in the sun's atmosphere, and that the disturbances do not generally extend over a wide range of heights.

2. *Correlation between many of the larger bursts.* Many of the larger bursts are similar in shape and nearly coincident in time. Bursts which are obviously associated in this way occur occasionally on all three frequencies, more often on the two closer ones. Presumably in these cases the disturbances extend through the requisite range of heights, either because the levels are closer or the disturbances of greater extent.

The majority of such associated bursts occur not simultaneously but in the sequence 200, 75, 60 Mc./s. The observed times of delay show considerable scatter; but, of sixty cases of such associated bursts on 75 and 60 Mc./s., the most common delay is 2 sec. That between 200 and 75 Mc./s. is of the same order, but the value is doubtful, owing to the few cases in which identification of corresponding bursts is possible. In the limited observations on 30 Mc./s., some bursts were observed which occurred a few seconds after similar bursts on 60 Mc./s. This time delay in the occurrence of bursts on different frequencies may be due to selective group retardation of the radiation in its passage through the ionized solar atmosphere, or to the excitation of radiation at successive levels by an agency travelling with finite velocity.

3. *Long time delays between some large outbursts.* Longer delays of several minutes duration have been observed occasionally between outbursts of exceptionally high intensity, in the same sequence 200, 75, 60 Mc./s. An outstanding example was the great outburst of noise on March 8, 1947, which was accompanied by a solar flare and a radio fade-out. On this occasion the recording frequencies were 200, 100 and 60 Mc./s. Our own 200 Mc./s. equipment was out of action, but a record was obtained by Mount Stromlo Observatory and is used here with their permission. There was a delay of 2 min. between the onset of the outburst on 200 and 100 Mc./s., and 4 min. between 100 and 60 Mc./s. The accompanying graph shows the time-sequence of events with the time of the radio fade-out. Observers at Mount Stromlo report that when optical observations commenced at 0440 a flare was in progress and already decreasing, and had disappeared by 0450. Incidentally, the noise intensity observed on 60 Mc./s. (off-scale at 10^{-9} watts/metre^2/megacycle band-width) is the greatest of which we have record.

The successive delays between the onset of the outburst on 200, 100 and 60 Mc./s. suggest that the outburst was related to some physical agency passing from high-frequency to lower-frequency levels. If we assume, following ideas suggested by Martyn[2], that the radiation at any frequency originates near the level where the coronal density reduces the refractive index to zero, we can derive a rough estimate of these heights from electron-density data given by Baumbach[3]. As the outburst showed no circular polarization on either 60 or 100 Mc./s., the ordinary ray has been considered. The electron densities and heights corresponding to the three frequencies are shown in the accompanying table, together with the velocity of the presumed disturbing agency.

Frequency (Mc./s.)	Electron density per c.c.	Height above base of corona (H) in km.	Delay of onset of outburst (ΔT)	Velocity$\left(\frac{\Delta H}{\Delta T}\right)$
200	5×10^8	0	2 min.	750 km./sec.
100	$1{\cdot}2 \times 10^8$	9×10^4	4 min.	500 km./sec.
60	$0{\cdot}4 \times 10^8$	20×10^4		

It is noteworthy that the derived velocities are of the same order as those of prominence material (some hundreds of kilometres per second) and of auroral particles (1,600 km. per second). An aurora was in fact observed in some parts of Australia on the evening of March 9, a little more than a day after the outburst.

This work is part of the research programme of the Council for Scientific and Industrial Research. We are indebted to the Commonwealth Astronomer for information on the solar flare and the 200 Mc./s. noise during the great outburst of March 8, and to the Overseas Telecommunications Commission (Australia) for information on the radio fade-out on the same date. Of our own colleagues we should particularly like to thank Dr. J. L. Pawsey for his interest and helpful discussions throughout all phases of the work.

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May 21.

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[1] As reported by Reber, G., and Greenstein, J. L., *Observatory*, 67, 15 (1947).

[2] Martyn, D. F., *Nature*, 159, 26 (1947).

[3] Baumbach, *Ast. Nach.*, 263, 121 (1937).

Residual Lattice Strains in Plastically Deformed Metals

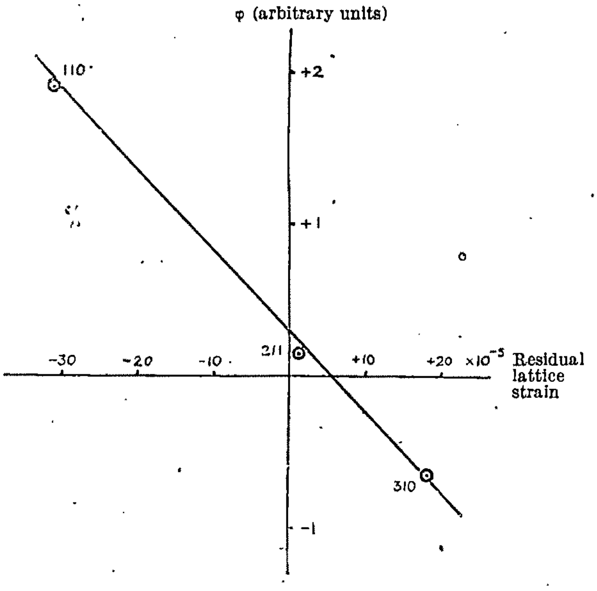
By measuring the change of the atomic interplanar spacing during a tensile (or compressive) test by means of X-ray diffraction methods, the 'lattice strain' can be plotted as a function of the stress. Such stress-*v*.-lattice strain curves, studied particularly by Smith and Wood[1], show that the lattice strain does not vanish when the applied stress is removed from the plastically deformed metal. This residual lattice strain must be due to microscopic residual stresses[2], and an investigation of the residual strains helps to clarify the origin and distribution of these.

In the present communication it is shown that the internal stresses arise mainly from the plastic anisotropy of the metal. The tensile stress required to cause glide in a given grain—the 'yield tension' of the grain—depends on the orientation of the glide planes and glide directions. In a polycrystalline aggregate deforming plastically under a tensile stress, grains with a high-yield tension will carry a greater stress than their neighbours, the orientations of which are such that they glide more easily. On removing the applied load a complicated stress system will arise in the aggregate; grains of high-yield tension will, in general, remain in tension, and those of low-yield tension will be in compression. The X-ray diffraction technique picks out grains of certain orientations, the normals to the reflecting planes being in a direction fixed geometrically by the X-ray beams. The 'residual lattice strain' found from a given X-ray reflexion is not the mean of the strains of all the grains, which is zero, but a mean of the strains of grains with particular orientations. This in general will not be zero; it must be expected to vary with the particular reflecting plane examined, and both positive and negative values should be found, depending on the choice of reflecting plane. On the other hand, an explanation of the residual lattice strain of the type proposed by Smith and Wood[1] would seem to demand that all reflexions should show approximately the same value.

Experimental work carried out to test the validity of the hypothesis outlined was as follows. Annealed metal wires of about 0·5 mm. diameter and extended plastically to the breaking point were photographed in a 19-cm. Bradley–Jay X-ray diffraction camera. Several characteristic X-radiations were used to obtain reflexions at high θ values for as many planes as possible. The strains for each reflecting plane were obtained by comparing the lattice spacings obtained from these photographs with those obtained from photographs taken of the same pieces of wire after re-annealing. The strains were always measured in a direction normal to that of the applied stress. In the results a residual lattice strain of sign opposite to the strain produced by the originally applied stress is denoted positive. Using this convention, the residual strains shown in the curves of Smith and Wood are always positive.

RESIDUAL LATTICE STRAINS FOR VARIOUS REFLECTING PLANES AFTER PLASTIC EXTENSION

Metal	Plane reflecting	Residual lattice strain
Iron	310	$+18 \times 10^{-5}$
	211	+1
	110	−31
Magnesium	$10\bar{1}5$	−3
	$12\bar{3}3$	+3
	$11\bar{2}4$	+2
	$20\bar{2}3$	0
	$10\bar{1}4$	−7
	$20\bar{2}5$	−3
	$12\bar{3}1$	+4
	0006	−5
	$30\bar{3}2$	+2
	$20\bar{2}4$	+3
	$30\bar{3}0$	+4



The table shows the results obtained for iron and for magnesium, the probable error of the residual lattice strains being about 1×10^{-5}.

For iron, a rough estimate of the average yield tension for grains of various orientations can be made from calculations performed for single crystals. If φ denotes the excess of the average yield tension for those grains contributing to a given reflexion over the mean value for all the grains in the aggregate, then it can be shown that a plot of the residual lattice strain against φ for various reflecting planes should be a straight line through the origin with a negative gradient. This graph is shown in the figure.

Similar results have been obtained with copper and aluminium, and it is considered that they afford confirmation of the hypothesis put forward.

The calculations of the yield tension indicate that this quantity varies rapidly with the angle between the applied stress and the reflecting normal. This angle is 90° in the experimental method used here, and about 80° for the usual back-reflexion camera technique; it is impossible to compare results obtained by the two methods. Further work is being undertaken to investigate the possible effect of specimen size and shape on the residual lattice strain.

This work has been carried out for the Royal Aircraft Establishment as part of a programme for the development of the X-ray method of measuring locked-up stresses in fabricated metal parts.

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May 12.

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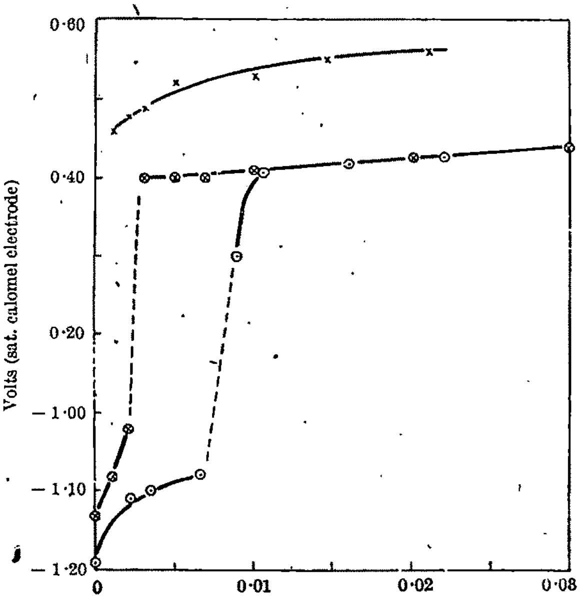
[1] Smith and Wood, *Proc. Roy. Soc.*, A, 182, 404 (1944).

[2] Heyn, Festband K. W. Gesellschaft, 131 (1921). Masing, *Wiss. Siemens Konzern*, 5, 135, 142 (1926).

Anodic Behaviour of Mild Steel in Strongly Alkaline Solutions

In connexion with the well-known intercrystalline failure of mild steel in concentrated solutions of sodium hydroxide, it would appear that a study of the anodic behaviour of iron in such solutions might lead to results of considerable interest. A search of the literature soon reveals, however, that but little attention has been devoted to this matter. The work of Grube and Gmelin[1], who carried out a careful and extensive investigation in this field, is therefore of special importance. These workers obtained evidence that anodic dissolution takes place in two distinct potential stages: at low current densities electrolysis proceeds at a potential of about – 0·85 V. (hydrogen), whereas at higher values it changes suddenly to + 0·65 V., when oxygen evolution commences. The critical current density was found to increase rapidly with temperature. Evidence is adduced by Grube and Gmelin that the lower (more negative) potential stage is associated with the formation of ferrous ion, and the higher with oxidation to the hexavalent ion $Fe^{6\cdot}$; anionic complexes being formed having the probable compositions $(FeO_2)''$ and $(FeO_4)''$ respectively.

I have carried out a few exploratory experiments on similar lines, with special reference to the influence of the molality of the solution. I used unstirred solutions, with a vertical electrode, though the degree of agitation and the position of the electrode appear to have little influence in this case. Some results are represented in the accompanying figure. These refer to a dead soft mild steel (0·05 per cent carbon) and were obtained at 80° C. The curves of potential against the saturated calomel electrode are plotted to a base of apparent current density.



ANODIC ELECTROLYSIS OF MILD STEEL IN AQUEOUS SODIUM HYDROXIDE: ×, 1·5 *M*; ⊕, 6·2 *M*; ⊙, 12·9 *M*

A certain amount of instability of the lower potential stage was observed near the critical current density, especially at the lower molalities. Further work indicated that this effect was attributable to the influence of time, in that the electrode tended to become passive at a current density considerably below the supposed critical value, provided sufficient time were allowed; for example, in a 12·9 molar solution, in which the apparent critical current density was about 0·003 amp./cm.², the electrode became passive after 40 minutes at 0·001 amp./cm.², and after 10–12 minutes at 0·002 amp./cm.².

A simple and plausible explanation of the existence and quasi-stability of the lower potential stage seems possible on the following lines. As is customary in such work, and like Grube and Gmelin, I subjected the anode to a previous cathodic polarization in order to remove the air-formed oxide film on the metal. Now experiments in a somewhat different connexion have shown that hydrogen is occluded by iron when the latter is cathodized in strongly alkaline solutions in quantities which increase rapidly with the strength of the solution. It seems probable, therefore, that during the initial stages of anodic polarization this occluded hydrogen will effectively prevent the formation of an adherent oxide film and consequent onset of passivity[2].

It is hoped to supplement these initial results and to publish a fuller account of this work later.

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[1] Grube and Gmelin, *Z. Elektrochem.*, 26, 459 (1920).

[2] Cf. Carius, "Korrosion metallischer Werkstoffe" (ed. Bauer-Kröhnke-Masing, Leipzig, 1936), 1, 135.

X-Ray Diffraction Studies of Yielding in Mild Steel

SIMILAR results to those described by J. M. Cowley and M. S. Paterson in their communication in *Nature*[1] concerning the examination of 'Hartmann's lines' (also known as 'Lüders' lines') in steel using X-ray diffraction methods were reported by me in 1927 [2], and again in 1937 [3] in consequence of a fuller investigation of steel and 'duralumin'. That was the first time the result of X-ray diffraction studies of 'Hartmann's lines' was published, so far as I am aware. Researches on the subject of 'Hartmann's lines' in steel, including a study of their properties, and of which my first memoir was a part, were carried out in the Department of Metallurgy of the University of Birmingham by Mr. T. Henry Turner, Dr. J. D. Jevons and myself, being under the supervision of the first-named.

A noteworthy disclosure in Messrs. Cowley and Paterson's communication is the presence of a considerable proportion of diffuse spots (indicating distorted crystals) with respect to the metal near a 'Hartmann's line' near the centre of a region of 'Hartmann's lines' but not actually forming any part of a 'Hartmann's line' (see their Fig. 1 and Fig. 2 *d*), whereas almost all the spots are diffuse if the part under examination is all part of a 'Hartmann's line'. Further X-ray diffraction studies of such distortion near 'Hartmann's lines' would be of much interest.

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[1] *Nature*, 159, 846 (1947).

[2] Fell, E. W., Carnegie Scholarship Memoirs (Iron and Steel Institute), 16, 126 and Fig. 17, Pl. xiii (1927).

[3] Fell, E. W., Carnegie Scholarship Memoirs (Iron and Steel Institute), 26, 135 and Figs. 19–30. Pls. xiii–xviii (1937).

[4] Fell, E. W., *J. Iron and Steel Inst.*, 132, 75 (1935).

Smears of Titanium Metal

A REMARKABLE phenomenon is shown by metallic titanium when rubbed against many hard surfaces. If a piece of the metal with a rounded end, of radius of curvature about 1 mm., is pressed firmly on to a hard surface and drawn across it, the metal is left behind in the form of a silvery smear. Smears are obtained with greater difficulty on some substances than on others, but only one crystalline material has been found on which no smear is produced (see accompanying table). The titanium metal may be removed by treatment with hot concentrated hydrochloric or sulphuric acids for about half an hour, or by treatment with cold commercial hydrofluoric acid for a few seconds. Some surfaces which were originally smooth and shiny are seen to have lost their polish after the titanium has been dissolved away. In this way, for example, it is possible to remove the polished surface of glass by rubbing with titanium and then dissolving the metallic smear in hydrochloric acid. The table gives a summary of the results obtained on a number of crystalline materials and on glass.

On Moh's scale the hardness of titanium is less than 5, since it is scratched by apatite but not by fluorspar. It will be seen that in the first place we have the result that a material of hardness 5 can destroy the surface of a crystal of hardness 8, namely, topaz[1]. Among the oxides the surface smoothness is affected only with difficulty or not at all, whereas all the silicates except beryl are readily attacked.

Chemical reaction brought about by rubbing two materials together is well known, and these effects may be due to some chemical reaction of the titanium with the materials on which it is rubbed. The readiness with which silicates react suggests that the titanium may enter into the lattice.

The practical applications of the smears may be (*a*) to coat materials with a metallic layer, (*b*) to etch glass without hydrofluoric acid, and (*c*) to form high resistances of the order of 10^{11} ohms; lines drawn on glass form such resistances, and although not stable against all changes of atmospheric conditions, they are sufficiently stable to be useful.

This investigation arose from a suggestion of Mr. J. B. Nelson and was made possible by a gift of a piece of titanium from Mr. H. F. Kay; we gratefully acknowledge this help. We are indebted to the Department of Mineralogy and Petrology for access to the mineral specimens on which the tests were made.

	Substance		Smear produced		Polish on surface removed		
Name	Chemical formula	Hardness (Moh's scale)	Readily	Not at all	Completely	Partially	Not at all
Diamond	C	10	×				×
Corundum	Al_2O_3	9	×				×
Hæmatite (specular)	Fe_2O_3	5·5–6·5	×			×	
Hæmatite (kidney ore)				×			×
Magnetite	Fe_3O_4	5·5–6·5	×			×	
Rutile	TiO_2	6	×			×	
Chrysoberyl	$BeO.Al_2O_3$	8·5	×				×
Spinel	$(Mg,Fe)O, Al_2O_3$	8	×				×
Quartz	SiO_2	7	×		×		
Topaz	$(Al,F)_2SiO_4$	8	×		×		
Diopside	$CaMg(SiO_3)_2$	5–6	×		×		
Beryl	$Be_3Al_2Si_6O_{18}$	8	×				×
Albite	$NaAlSi_3O_8$	6	×		×		
Axinite	$HCa_3BAl_2(SiO_4)_4$	7	×		×		
Epidote	$HCa_2(Al,Fe)_3Si_3O_{13}$	6–7	×		×		
Garnet	$Ca_3Al_2(SiO_4)_3$	7	×			×	
Tourmaline		7	×		×		
Glass		5	×		×		

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[1] Bowden, F. P., Moore, A. J. W., and Tabor, D., *J. Appl. Physics*, 14, 80 (1943.)

Furansulphonamides

As a recent issue of *Chemical Abstracts* contains an account of the preparation of the sodium and barium salts of furan-2-sulphonic acid[1], by the direct sulphonation of furan, the following report on the indirect production, from pyromucic acid, of simple sulphonation derivatives of furan may be of interest.

The diamide of pyromucic-5-sulphonic acid was prepared, by the method of Hill and Palmer[2], and converted, with barium hydroxide, to furan-2-carboxylic acid-5-sulphonamide

$$C_4H_2O(CONH_2)SO_2NH_2 \longrightarrow C_4H_2O(COOH)SO_2NH_2.$$

Substituted sulphonamido acids were obtained from the dichloride of pyromucic-5-sulphonic acid, as indicated schematically below.

$$C_4H_2O(COCl)SO_2Cl \xrightarrow{CH_3OH} C_4H_2O(COOCH_3)SO_2Cl \xrightarrow{R_1R_2NH} C_4H_2O(COOCH_3)SO_2NR_1R_2 \xrightarrow{NaOH} C_4H_2O(COONa)SO_2NR_1R_2.$$

The above acids were decarboxylated by the method of Gilman and Wright[3].

$$C_4H_2O(COONa)SO_2NH_2(R_2) \xrightarrow{HgCl_2} C_4H_2O(HgCl)SO_2NH_2(R_2) \xrightarrow{HCl} C_4H_3O.SO_2NH_2(R_2).$$

Furan-2-sulphonamide (m.p. 122–123·5°), furan-2-sulphonyl methyl anilide (m.p. 95–98°) and furan-2-sulphonyl-diethylamine, a liquid, were thus prepared.

Furan-3-sulphonic acid and its derivatives were obtained as follows: Pyromucic acid was brominated to the 5-bromo acid, which was sulphonated and the carboxylic group replaced by bromine, as described by Hill and Palmer[4]. The barium 2-5: dibromofuransulphonate thus obtained was treated with zinc and ammonium hydroxide, which replaced the bromine atoms by hydrogen, giving barium furan-3-sulphonate. From this salt was prepared the *p*-toluidine salt (m.p. 172–173°), and the free acid, an oily liquid, which was reconverted into the barium salt, and the *p*-toluidine salt. The impure sodium salt was obtained, in the usual way, and converted into the sulphonic chloride, from which furan-3-sulphonamide (m.p. 106–108°) and furan-3-sulphonylmethylanilide (m.p. 95–97°) were prepared.

A detailed account of this investigation will appear shortly.

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[1] Terent'er, A. P., and Kazitoyra, L. A., *Chem. Abs.*, 41, No. 7, 2033 (1947).

[2] *Amer. Chem. J.*, 10, 378 (1888).

[3] *J. Amer. Chem. Soc.*, 55, 3311 (1933).

[4] *Amer. Chem. J.*, 10, 413 (1888).

Identification of Creatine by Partition Chromatography

IN a study of creatinine metabolism in the rat, to be published elsewhere, creatinine has been identified qualitatively by means of the technique of partition chromatography on paper strips developed by Consden, Gordon and Martin[1]. The apparatus described by Dent[2] has been used, with the further refinement of accurate temperature control obtained by immersing the outer glass container in a water thermostat at 15 ± 0·05° C. Solutions containing *c.* 20–30 γ of creatinine were pipetted on to the paper strips, and after treatment with an appropriate solvent, for example, collidine for 24 hours, the creatinine bands were located by spraying with alkaline sodium picrate.

Some rat urines examined in this manner showed, in addition to a creatinine band, a further Jaffé positive band corresponding to a substance of lower R_f value than creatinine. The second band has since been shown to arise from the creatine, present in the urine, which had undergone movement in the solvent and which had been dehydrated to creatinine during the drying of the paper strips. By means of acid treatment of the strips it is possible to convert creatine more completely to its anhydride *in situ*, and in this way to determine R_f values for creatine.

Further, this procedure affords a method for determining creatine qualitatively in the presence of creatinine, the method adopted being as follows: the test material is pipetted on to the strip and is treated with the appropriate solvent. The strip is dried at 100° C., sprayed with 0·5 N sulphuric acid and again heated at 100° C. for 1 hour. Creatine is located on the strip as creatinine by spraying with alkaline sodium picrate. R_f values determined at 15° C. for creatine and creatinine (solvent collidine) both in pure solutions and in rat urine are given in the accompanying table.

	Pure solution	Rat urine
Creatine	0·19	0·15
Creatinine	0·47	0·57

Each figure represents an average of at least six values, the maximum variation obtained being 9 per cent. The R_f values for creatine are sufficiently far removed from those of creatinine to enable clear-cut separation of these substances, and it is therefore possible to identify creatine qualitatively in the presence of considerable amounts of its anhydride.

Further solvents giving suitable R_f values for these two substances are being tried. Creatine and creatinine in phenol move as fast as the solvent. Creatinine shows no movement in amyl alcohol, but has a low R_f value in n-butyl alcohol (creatinine in pure solution: 0·20; creatinine in rat urine: 0·25).

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[1] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, 38, 224 (1944).

[2] Dent, C. E., *Lancet*, ii, 637 (1946).

Enzymatic Hydrolysis of Cellulose by *Coniophora cerebella*

DURING the course of the investigation of the enzymatic activities of wood-destroying moulds[1], an attempt was made to depict the phase sequence of the degradation of the cellulosic fraction of wood; cellulose itself, in the forms of filter paper and surgical cotton, was utilized. *Coniophora cerebella* was found to degrade both forms of cellulose to oxalic acid. Inasmuch as traces of reducing material were found to be formed, and oxalic acid was also obtained by the action of the fungus on glucose, it appeared that an introductory hydrolysis was a necessary prerequisite for the formation of oxalic acid.

A hydrolytic action being involved, it was found useful to examine the residual cellulosic material to determine whether there was an increase or decrease in reducing power. If one were to assume that a hydrolysis similar to that by acids took place, then there would be an increase in reducing power due to the formation of new reducing groups. On the other hand, a split of semi-acetal bonds, the existence of which was first surmised by Tollens, might take place, with the result that the residual material would show a lower reducing value.

Some experiments by Hiller and Pacsu[2] indicated that an *initial* rapid acid hydrolysis of cellulose causes a split of semi-acetal bonds, permitting a *decrease* in reducing power. Consequently, speculation arose whether an enzymatic degradation of cellulose would follow such a pattern, or whether the mould effects a split of 1,4-glycosidic bonds to give rise to new reducing groups.

Surgical cotton which was degraded by *Coniophora cerebella* over a period of sixty days was examined at certain intervals, employing the analytical technique of Hiller and Pacsu, which requires the use of dilute acidic permanganate solution for the determination of reducing power. An inspection of the values recorded in the accompanying table indicates an *increase* in reducing power of the residual cellulose as the oxalic acid content increases:

DISSIMILATION OF SURGICAL COTTON BY *Coniophora cerebella*

Incubation period Days	Oxalic acid (mgm.)	Milli-equivalents oxygen used up
0	0	0·0500
13	2·35	0·1201
30	6·30	0·2612
60	6·40	0·2668

Values expressed per 1 gm. samples of surgical cotton.

It would appear that the *enzymatic* degradation of cellulose effects a split of 1,4-glycosidic bonds rather than, or concomitant with, a split of semi-acetal linkages.

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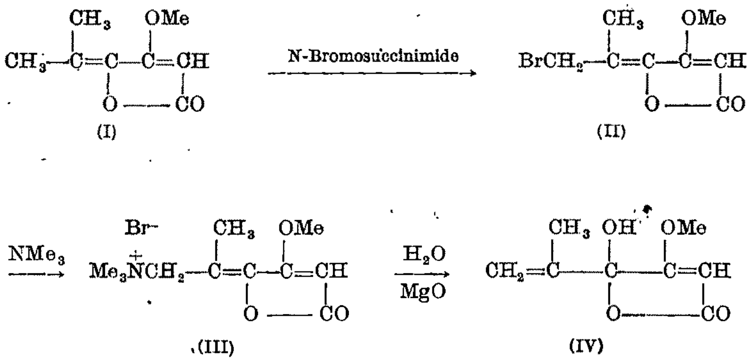
[1] Nord and Vitucci, *Nature*, 160, 224 (1947).

[2] Hiller and Pacsu, *Text. Research J.*, 16, 490 (1946).

Synthesis of the Antibiotic, Penicillic Acid

PENICILLIC acid, first isolated by Alsberg and Black[1] from *Penicillium puberulum* Bainier and later by Birkinshaw, Oxford and Raistrick[2] from *Penicillium cyclopium* Westling, was shown to possess the structure (IV) by the latter authors. Later it was observed that the compound was a powerful antibacterial agent, and Oxford[3] has determined that it is much more active than penicillin against Gram-negative organisms.

Penicillic acid has now been synthesized from the lactone (I)[4] as follows:



Treatment of (I) with N-bromosuccinimide gives the bromolactone (II) which, on warming with aqueous trimethylamine, yields the quaternary bromide (III). On boiling an aqueous solution of (III) with excess magnesium oxide, trimethylamine is evolved and penicillic acid (IV) is produced directly. The yields in all the above stages are substantially quantitative.

The mechanism of the last step is formulated thus. The quaternary bromide is first converted to the quaternary hydroxide, which then undergoes the rearrangement already encountered in this field[4]. This has the net effect of adding the elements of water across the double bond. Finally, occurrence of the familiar Hofmann reaction leads to penicillic acid.

The melting point of the synthetic acid is 86–87°, undepressed on admixture with the mould metabolic product; the acetyl and dibromo-compounds likewise give no depression in melting point when mixed with the corresponding derivatives prepared from the natural product. The natural and synthetic acids exhibit identical light absorption properties in the ultra-violet.

The last stages of the above synthesis were carried out during the tenure of an Imperial Chemical Industries Fellowship awarded by the University of London.

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[1] U.S. Dept. Agric. Bureau Plant Ind. Bull., Nos. 119, 270.

[2] *Biochem. J.*, 30, 394 (1936).

[3] *Chem. and Ind.*, 61, 48 (1942).

[4] Raphael, *J. Chem. Soc.*, in the press.

Interpretation of the Exchange of Radio-Sodium in Isolated Muscle

KROGH, in his Croonian Lecture[1] before the Royal Society, considered the apparent impermeability of striated muscle to sodium to be due to an active extrusion of sodium ions. Discussing this view, Conway[2] calculated the minimal energy required for extrusion of sodium from the normal frog's sartorius if sodium entered as fast as potassium. The result was that more than the energy available from the metabolism of the resting muscle would be needed.

In our experiments, isolated frog sartorii were equilibrated with radio-sodium, and the washing out of the isotope was followed. We found that the exchange of the sodium of the muscle fibres with that of the outside medium occurs very rapidly. After correcting for interspatial sodium, it turned out that half the sodium of the fibres was renewed in about half an hour. The use of Ringer solution with high potassium content (12·5–30 mmol.) gave similar results. When the sodium content of the muscle fibres is known, it is possible to calculate the absolute amount of sodium entering and leaving the muscle fibres per unit time; and in the experiments with high potassium these two values differ but slightly. Using Conway's formula (*l.c.*) the rate of passage of sodium corresponds to more than 150 cal. per kgm. per hour at the actual ion concentrations of the experiments, if the exchange of sodium were a true measure of the sodium transported out.

There are, however, certain mechanisms which will allow an exchange of sodium ions between two phases at different concentrations without consumption of chemical energy. In the first place, an exchange without change in concentration may, of course, take place if the difference in concentration is maintained by an electric potential difference; for example, in the case of a Donnan equilibrium. But this cannot be the explanation in the case of the muscle, where the sodium moves out against the potential gradient, the interior of the cells being negative relative to the surrounding medium. In search for a reasonable explanation we may, for example, imagine the cell membrane as an oil layer with suspended particles of some 'Permutite' with an especially high adsorption affinity for sodium. The inside medium may contain radio-sodium at a low concentration, and the outside may contain ordinary sodium at a high concentration. We suppose that the Brownian movements bring one of the 'Permutite' particles into contact with the inside medium. Inactive sodium will then be exchanged with active; later, the particle may come in contact with the outside medium, and the active ions may be given off to this medium in exchange for ordinary ions. In this way, the statistical approach to an equal proportion between active and ordinary sodium ions on both sides of a membrane may proceed at a much higher rate than the approach to equal concentrations on both sides. This is only one of several possible mechanisms which will give the same result; as will also, for example, Lundegårdh's concept[3] of the cell membrane containing acid and basic groups which bind ions of the opposite charge and which sometimes turn round so that they are alternately in contact with both surfaces.

The muscle where the sodium passes out against a concentration gradient as well as against the electrical potential represents a case in which a mechanism similar to that outlined above seems the most reasonable explanation of the experimental facts. However, it must be pointed out that, generally, tracers cannot be used to measure the active transport of ions across a membrane without paying due regard to the fact that part of the apparent transport may be simple exchange.

A detailed account of the tracer experiments performed at this Laboratory will be published in the near future.

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[1] Krogh, A., *Proc. Roy. Soc.*, B, **133**, 140 (1946).
[2] Conway, E. J., *Nature*, **157**, 715 (1946).
[3] Lundegårdh, H., *Arkiv f. Botanik, Stockholm*, **32**, 12 (1945).

'Aerosporin', an Antibiotic Produced by *Bacillus aerosporus* Greer

A BACTERIUM isolated from the soil of a market garden in Surrey during February 1946 and afterwards from a Yorkshire soil and from the air has been found to produce an antibiotic of possible therapeutic importance for which, as it appears to be hitherto undescribed, the name 'Aerosporin'* is proposed. The production and properties of aerosporin are under investigation by a group of workers at the Wellcome Physiological Research Laboratories, and the purpose of the present communication is to direct attention to certain aspects of these studies, the results of which will be published in detail elsewhere.

The organism, a Gram-positive, spore-forming rod, has been identified by Mr. H. Proom with that described by Greer[1] from Chicago tap water as *Bacillus aerosporus*. *B. aerosporus* is considered by some authorities to be synonymous with *B. polymyxa* (Prazm.) Migula, and of three cultures so designated from the National Collection of Type Cultures, two (N.C.T.C. 4747, which originated from the Chicago Board of Health as *B. aerosporus*, and 1380) proved to possess similar antibiotic-producing activity, while one (N.C.T.C. 4745, from the United States and originally designated *B. asterosporus* (Meyer) Migula) did not.

The organism grows well in nutrient broth, but more satisfactory yields of antibiotic are obtained from half-strength broth to which sucrose or glucose and a trace of manganese has been added. In shallow layers at 28° C., the organism grows at the bottom of the culture fluid, where more or less mucilage is formed, depending on the choice of strain and medium. The antibiotic titre increases for four to seven days and then declines.

Aerosporin is a base, and methods for its extraction are similar to methods for streptomycin. Because the activity of the culture fluid is reduced by passage through a candle or a Seitz filter, the bacterial cells are removed by centrifugation. A convenient extraction procedure is one developed by Dr. C. G. Pope from the method for extracting streptomycin described by Van der Brook *et al.*[2] by which the aerosporin is adsorbed on to a suitable activated charcoal, the charcoal treated with dilute sulphuric acid, and the antibiotic eluted with aqueous acetone. The crude aerosporin sulphate is precipitated by the addition of dry acetone.

As described below, aerosporin is active against Gram-negative organisms, and the routine method for its assay has been a dilution method using *Escherichia coli* as the test organism. Two variants of the test have been used. In one the tests are read after approximately three hours incubation at 37° C.; in the other, after incubation overnight at 28° C.

Aerosporin is selective in its action against Gram-negative organisms. Among the more interesting of the pathogens against which it has proved chemotherapeutic in experimental infections in animals are *Hæmophillus pertussis*, *Eberthella typhosa* and *Escherichia coli* in the field of human medicine, and *Brucella bronchiseptica* and *Escherichia coli* strains of 'calf scour' in the veterinary field. The antibiotic is bactericidal in action, and, where attempted, cultural methods have failed to produce resistant strains.

Aerosporin is readily produced, is relatively stable, and in addition to its selective action is of high intrinsic potency. Weight for weight it has the same order of chemotherapeutic activity against Gram-negative organisms as has penicillin against Gram-positive.

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Beckenham, Kent.
May 19.

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* Application has been made by the Wellcome Foundation, Ltd., for the registration of the word 'Aerosporin' as a trade mark.

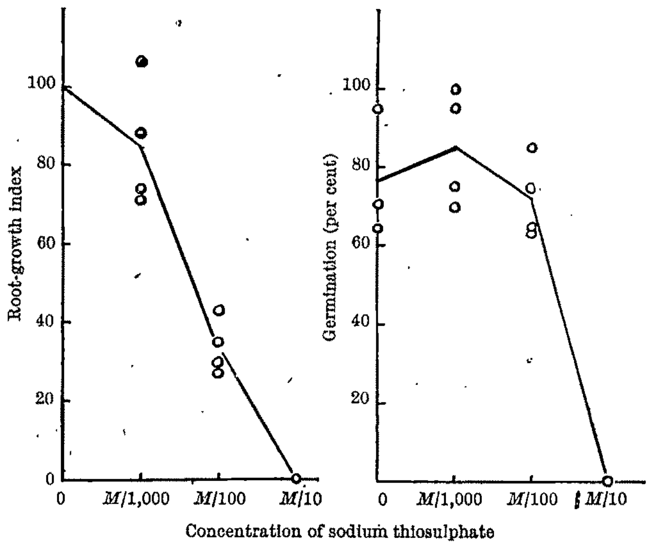
[1] *J. Infect. Dis.*, **42**, 508 (1928).
[2] *J. Biol. Chem.*, **165** (2), 463 (1946).

Selective Toxic Action of Thiosulphate on Plants

INVESTIGATIONS have been recently carried out on the effects of low concentrations of sodium thiosulphate on the germination and subsequent root growth of a number of plants. (These investigations were undertaken as a result of earlier work, not yet published, by Quastel, Hewitt and Nicholas, on the effects of thiosulphate on growth of crops in soils.)

The experiments were carried out with sterile seeds grown under rigidly sterile conditions by a technique recently described[1,2]. Three concentrations (namely, $M/1{,}000$, $M/100$ and $M/10$) of thiosulphate, together with controls, were used in normal culture solutions. Concentrations and controls were usually set up in triplicate, samples of 10–20 seeds being used in each tube or set of tubes. After a period of 7–10 days growth at 20–22° C. in artificial light (9 hours per day) the percentage germination and total weight of roots produced were found for each concentration. From these figures the 'root-growth index' (ratio of average weight of roots per seedling in thiosulphate solution to average weight of roots per control seedling multiplied by 100) has been calculated, and this gives a direct indication of root-growth inhibition by thiosulphate. This provides a rigid separation of the two effects (namely, on root growth and on germination).

Results for experiments on cress (*Lepidium sativum*) are seen in the accompanying figure, where root-growth index and percentage germination are plotted against a logarithmic scale of increasing thiosulphate concentrations. The straight lines join the mid-points of the observed values for each concentration. By interpolation, the concentration of thiosulphate necessary for 50 per cent inhibition of both root growth and germination can be roughly estimated. With cress these concentrations are $4{\cdot}7 \times M/1{,}000$ and $26 \times M/1{,}000$ for root growth and germination respectively.



GRAPHS SHOWING EFFECTS OF VARIOUS CONCENTRATIONS OF SODIUM THIOSULPHATE ON ROOT GROWTH AND PERCENTAGE GERMINATION OF CRESS (*Lepidium sativum*)

Similar calculations have been made from graphs constructed for other species investigated. These results appear in the accompanying table. Here the plants are arranged in order of decreasing sensitivity, judged on their root growth. It will be seen that there is a considerable range of sensitivity, from garden pea at the sensitive end of the scale to carrot at the insensitive end. On the whole, much higher concentrations are necessary to produce the same degree of inhibition of germination. Thus thiosulphate shows a considerable degree of selectivity in its toxic action on the growth of plant roots.

Plant	Concentrations producing 50 per cent inhibition	
	Of root growth	Of germination
Garden pea	$4 \cdot 0 \times M/1{,}000$	$31 \cdot 0 \times M/1{,}000$
Cress	4·7 ,,	26·0 ,,
Cabbage	6·0 ,,	20·0 ,,
Rape	10·0 ,,	25·0 ,,
Maize	11·0 ,,	31·0 ,,
Flax	20·0 ,,	33·0 ,,
Radish	25·0 ,,	80·0 ,,
Mustard	27·0 ,,	15·0 ,,
Carrot	41·0 ,,	38·0 ,,

The effects of two other sulphur compounds, sodium dithionate and potassium trithionate, on cress have been investigated. Neither of these compounds is as toxic as sodium thiosulphate, the concentrations necessary to produce 50 per cent inhibition of root growth being $39 \times M/1{,}000$ for dithionate and $53 \times M/1{,}000$ for trithionate (compared with $4 \cdot 7 \times M/1{,}000$ for thiosulphate).

It is hoped that experiments now in hand may elucidate the mechanism of these inhibitions.

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July 10.

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[1] Audus and Quastel, *Nature*, **159**, 320 (1947).

[2] Audus and Quastel, *Nature*, in the press.

Symbiosis in *Oliarius*

MAHDIHASSAN[1] has recently criticized my interpretation of symbiosis in the Fulgorid insect *Oliarius cuspidatus* Fieb., described by Šulc[2] in 1924. He states that what I interpreted as a mycetome is in fact the testis, the contents being spermatozoa rather than bacteria.

A glance at Šulc's figure, reproduced by Mahdihassan, should be a sufficient demonstration of the untenability of Mahdihassan's position. The object in question, which Šulc unfortunately called the 'interfollicular organ', has no efferent duct and is not composed of follicles. It is formed of a strange syncytium like that found in the bacterial-containing organs of cicad insects, with a low covering epithelium which sends thin septa into the cavity. This cavity is filled with long slender threads with scattered metachromatic nuclei in which all characteristics of sperm are lacking and which, without question, are bacteria.

Moreover, these so-called 'testes' are found in both sexes; and contrary to what Mahdihassan states, they have not been studied in this particular case alone. A pupil of mine, G. Richter[3] was able to study another species, *Oliarius horisanus* Mats., from Formosa, and found precisely the same type of complicated symbiotic arrangements in the female. Another pupil of mine, H. J. Müller, in his large "Monographie der Fulgoroiden-Symbiose", based on not less than 173 species, finds the same organs in both sexes of several species of *Oliarius* *O. panzeri* P. Löw, from Germany, *O. tantalus* Gifford from Hawaii, *O. villosus* F. and other unidentified species, from Brazil.

It was thus scarcely necessary for Mahdihassan to spend months at Brno, where Šulc made his studies collecting material of a very rare species, to prove me guilty of so gross an error.

P. BUCHNER

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Naples.

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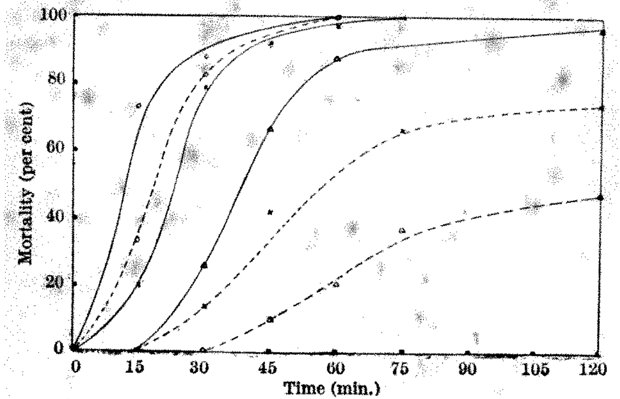
Inhibition of the Toxicity of 'Gammexane' for Insects

DURING the course of work on the effect of 'Gammexane' (pure gamma isomer of hexachlorocyclohexane) on the metabolism of fat, protein and carbohydrate by fourth-stage mosquito larvæ, it was observed that the concentration of 'Gammexane' tolerated in the presence of fat (olive oil) was higher than that in the presence of protein or carbohydrate. Further experiments with fourth-stage larvæ of *Aedes ægypti* and *Culex fatigens* confirmed this finding, and it was observed that liquid triglycerides in general provide a degree of protection for larvæ against 'Gammexane'. The findings of Buxton[1] and Upholt[2] indicate that this may be a similar phenomenon to that which results in the inactivation of D.D.T. when applied as a larvicide under natural conditions, suggested by Upholt to be due to adsorption by the organic constituents of mud.

The accompanying graph shows the effect of triolein (mixed in 5 per cent concentration on 0·1 gm. of kaolin) in reducing the mortality of larvæ exposed to



Full lines, 'Gammexane' + kaolin ; broken lines, 'Gammexane' + kaolin + triolein

—○— 1·6 p.p.m. 'Gammexane'
—×— 0·8 „ „
—△— 0·4 „ „

10 ml. of phthalate buffer of pH 4·0 (Wigglesworth[3]) containing varying concentrations of 'Gammexane', the control groups being tested in the presence of an equal quantity of kaolin alone. Of substances tested similarly, the following showed no protection: kerosene, refined liquid paraffin, cholesterol, tripalmitin and tristearin. Olive oil, soya bean oil, arachis oil and poppy-seed oil gave partial protection, while tributyrin, triolein, tricaprylin, tricaproin and tri-*n*-valerin showed in that order increasing ability to overcome the toxic effects of 'Gammexane'.

The results of further experiments indicate that this effect cannot be solely explained on the basis of the 'Gammexane' being removed from the aqueous phase by adsorption or solution into the triglyceride, but that the actual ingestion of the triglyceride is necessary. Thus refined liquid paraffin (in which 'Gammexane' is considerably more soluble than in water) does not decrease the toxicity at all (it is itself non-toxic under the conditions of testing). It is improbable that the quantity of 'Gammexane' adsorbed on the solid ingested affects the mortality when compared with the known large quantity of liquid circulated by larvæ[4]. Furthermore, pupæ of *A. ægypti* exposed to 1 p.p.m. of 'Gammexane' solution show no difference in mortality (reaching 100 per cent in 72 hours) whether in the absence or presence of triolein. The relative inefficiency of 'Gammexane' in killing pupæ is comparable to the complete lack of toxicity of D.D.T. towards pupæ[5,6,7]. It is clear that these compounds act more efficiently by ingestion than by contact in the case of mosquito larvæ.

EFFECT OF TRIOLEIN ON TOXICITY OF 'GAMMEXANE' FOR *C. lectularius*

Conc. of 'Gammexane' (mgm./sq. cm.)	Conc. of triolein (ml./sq. cm.)	Conc. of kerosene (ml./sq. cm.)	Observations after exposure of 1½ hr.	4 hr.	20½ hr.
0·05	0·00325	0·00325	Unaffected	Locomotor disturbance	All dead
0·05	0·0065	0	Unaffected	Unaffected	All dead
0·05	0	0·0065	Moribund or paralysed; unable to walk	Moribund or dead	All dead
0·1	0·0026	0·0026	Unaffected	Slight locomotor disturbance	All dead
0·1	0·0052	0	Unaffected	Slight locomotor disturbance	All dead
0·1	0	0·0052	Moribund or paralysed; unable to walk	Moribund or dead	All dead

When tested against recently hatched unfed adults of *Cimex lectularius*, the toxicity of 'Gammexane' acting purely as a contact insecticide was also found to be reduced by triolein. The bugs were placed in groups of 10 on filter papers (7 cm. diameter) to which had been applied various mixtures of an acetone solution of 'Gammexane', kerosene and triolein, followed by air-drying for 48 hours before testing. The results, for which no obvious explanation suggests itself, are shown in the accompanying table.

It is of interest to note that when fed to a rabbit, 'Gammexane' mixed with olive oil does not lose its toxicity for bedbugs afterwards fed on the animal. Further, we have been unable to show that *i*-inositol exerts any inhibitory action against 'Gammexane' in tests with mosquito larvæ. The results of our experiments with mosquito larvæ serve to amplify the observations of Buxton[1] and Upholt[2] concerning the loss of toxicity of D.D.T. when used as a larvicide. If, as suggested by Buxton, D.D.T. dissolves from oil into water in concentration sufficient to be larvicidal, or as Arnold *et al.*[5] conclude, is precipitated out on evaporation of the oil, then the eventual adsorption on the organic constituents of the bottom mud and the intervening ingestion by larvæ of the toxic agent (in aqueous solution or in a state of fine suspension) from subsurface levels would appear to be a factor of some import in the application of larvicides for control of breeding. The greater solubility of 'Gammexane' compared to D.D.T. therefore offers possibilities for more efficient control, particularly of those larvæ which do not rise to the surface (for example, species of the genus *Tæniorhynchus*).

We are indebted to Dr. Walmsley, of African Explosives and Chemical Industries Ltd., for supplies of 'Gammexane', and to Miss U. B. Arvidson for technical assistance.

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April 28.

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[3] Wigglesworth, V. B., *J. Exp. Biol.*, **19**, 56 (1942).
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Urceolarian Epizoites of Flatworms

PERITRICHS (Urceolaridæ) living on the surface of flatworms seem to afford suitable material for a study of the population dynamics of the epizoic habit. The host is widespread, occurs in large numbers, and the smooth surface enables rapid estimation of the numbers of the epizoite. A technique has been developed whereby some twenty flatworms can be dealt with in an hour.

Up to date, two species of Urceolaridæ, *Urceolaria mitra* v. Sieb. and *Trichodina steinii* Clap. et Lach., have been recorded from five species of flatworm. There is also a considerable body of descriptive work on these two ciliates; but the ecology seems to have been neglected. The existence of a pond with a large flatworm population in the grounds of the Memorial Buildings, University College, Bangor, has afforded an opportunity of studying the seasonal population changes in *U. mitra*, and some interesting results are emerging. Two species of flatworm abound here, *Polycelis nigra* and *Dugesia lugubris*. Early work suggesting that the epizoite was confined to the former species was confirmed by examining four samples of worms from different parts of the pond. Of fifty-three *P. nigra* taken, all carried the ciliate, whereas the twenty-four *D. lugubris* were negative. Host specificity seemed absolute under natural conditions. No similar record has been found, although Peshkowsky[1] noted that both peritrichs were more abundant on *P. nigra* than on *Dugesia torva* or *D. lugubris*. So far, *T. steinii* has not been found in this pond, although more than five hundred flatworms have been examined.

The preference for *P. nigra* has been tested experimentally by exposing both species of worm simultaneously to *Urceolaria* in watch-glasses. Successful attachments were noted after two days—under experimental conditions *Urceolaria* rarely lived longer, unattached. In ten tests an average of four out of ten (limits, 1–7) *Urceolaria* became attached to *P. nigra*. They did not attach to *D. lugubris*, confirming the field preference. In further experiments *D. lugubris* alone was exposed, and in three out of ten tests attachment occurred, the numbers being 2, 1 and 3. In the last case the peritrichs lived at least eleven days. Thus under certain conditions specificity is not absolute, recalling Fulton's work[2] on the transference of *T. pediculus* from *Hydra* to the gills of Amphibia. Results suggest that the basis of field specificity may be the amount of pigment and its distribution—it does not seem to be ecological.

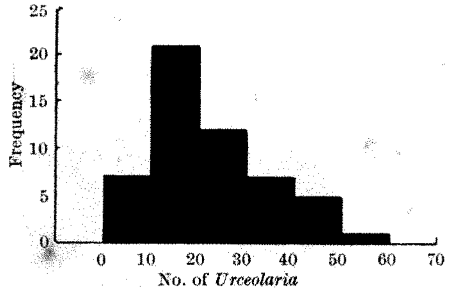

Fig. 1. URCEOLARIAN POPULATION OF *Polycelis nigra*

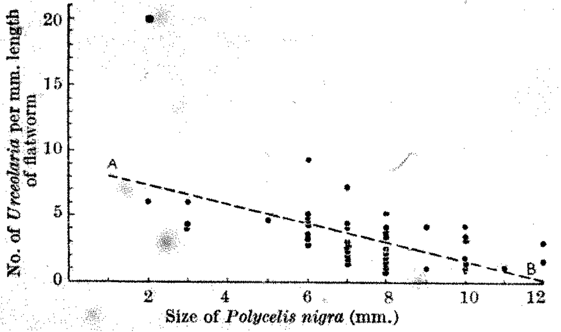

Fig. 2. NO. OF *Urceolaria* PER MM. LENGTH ON *Polycelis nigra*; *AB* IS THE REGRESSION LINE

Paucity of British records of this association[3] suggests that it is infrequent, but examination of flatworms from three other habitats in the Bangor district all yielded Urceolarians. *Polycelis cornuata* carried both species and is a new host record. Not only is the incidence of the epizoite high, but also individual flatworms may carry large populations. Fig. 1 summarizes the data for the College pond; the average number was 22 with limits of 6–55. Arrangement of the data in the form of a trend relating the Urceolarian population to flatworm size shows that the larger specimens do not carry a larger epizoic fauna. It follows (Fig. 2) that the larger flatworms carry a smaller population per unit area. The negative correlation between worm-size and the ciliate population is statistically significant. No explanation of this result, confirmed by later work, is available yet.

It is proposed to study the basis of host specificity, the ecological links between epizoite and host and the factors controlling the size and fluctuations of the peritrich population.

I am indebted to Miss M. Henderson for assistance in the field work and the preparation of this note.

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University College of North Wales,
Bangor. May 9.

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A Fluorescent Reaction of Tryptophane

IN studying the colour reactions of tryptophane, described by J. Tillmans and A. Alt[1], an intense yellow fluorescence under ultra-violet light was observed.

This reaction has been somewhat improved by me for the purpose of fluorescent analysis. It is carried out by adding to 0·5–2 c.c. of the solution of tryptophane in a test-tube a few drops of a dilute solution of formaldehyde (about 4 per cent); the mixture is then shaken, and concentrated sulphuric acid cautiously poured to the bottom. At the contact of the liquid layers a yellow-brown ring appears, which shows intense yellow fluorescence under ultra-violet light. This fluorescence is readily observable with the naked eye in solutions containing 5 γ per c.c., that is, in a dilution of 1 : 200,000. After shaking, the whole solution shows yellow fluorescence. Solutions containing only the tryptophane fluoresce a bright blue under ultra-violet light.

I have not yet succeeded in isolating the fluorescent colouring matter. It is possibly a 4-carbolin derivative, as a carbolin ring is readily formed by the action of aldehydes upon tryptophane[2,3].

The colouring is permanent. The intensity of fluorescence remains in a stoppered test-tube unchanged for several months.

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[1] Tillmans, J., and Alt, A., *Biochem. Z.*, **164**, 135 (1925).
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ACTIVATION OF COPPER BY OXIDATION AND REDUCTION

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PRELIMINARY X-ray observations on the crystalline changes produced in the metallic and oxide films of copper during the activation process appear to supplement the results of Garner and Stone[1]. The accompanying X-ray diagrams were obtained from narrow slivers of rolled copper sheet 0·0025 in. thick, using copper K_α radiation filtered through nickel foil to remove the β component. A flat quadrant plate spectrometer was used for the comparative X-ray measurements.

In each photograph, quadrants 1 and 3 show the reflexions from the (111) and (020) planes of the bright copper sheet together with faint reflexions from oxide inclusions. These photographs are typical of a metallic structure which is made up of finely divided crystals with preferred axes of orientation due to the rolling process. This specimen was to all intents and purposes inactive as a catalyst.

Quadrants 2 and 4 of Fig. 1 show the X-ray diagram of a sliver of copper strip after oxidation in air at about 850° C. for approximately five minutes. From this X-ray photograph two points are clear: (1) The remaining copper phase has recrystallized into a macro-crystalline form, with destruction of the preferred orientation. (2) The oxide phase is in the form of a finely divided powder which appears to be a mixture of cupric and cuprous oxides.

Quadrants 2 and 4 of Fig. 2 show an X-ray diagram of an oxidized sample of foil after reduction in hydrogen at 250° C. over a period of about one hour and at such a rate that no destruction of the catalytic action of the material was caused by local increases in temperature. The resulting metallic copper can be seen in two forms: one finely divided, from which the reflexions formed a continuous ring on the X-ray diagrams (quadrants 2 and 4, Fig. 2), and the other giving a series of reflexions from individual macroscopic crystals.

During this reduction process, control of temperature is vitally important; in general, it can be said that as the temperature is increased above the optimum of about 250° C., the catalytic action of the resulting copper decreases.

In our opinion, the probable mechanism of activation is as follows.

The outer surface of the copper sheet is oxidized to Cu_2O, which increases the volume occupied by the four copper atoms of the cubic unit cell[2] of the metallic state from $(3{\cdot}608\ \text{A.})^3 = 46{\cdot}93\ \text{A.}^3$ to $(4{\cdot}25\ \text{A.})^3 = 76{\cdot}87\ \text{A.}^3$ in the cubic unit cell comprising two Cu_2O molecules[3], with consequent change in density from 8·93 gm./c.c. to 6·14 gm./c.c. To achieve this, an obvious break-up of the surface of the copper must occur, even though the finely divided crystals of the original sheet are sufficiently mobile to recrystallize into a macro-structure. The further oxidation to cupric oxide also causes an additional slight increase in volume, since the monoclinic cupric oxide unit cell[4] contains four CuO molecules in a volume of $4{\cdot}653 \times 3{\cdot}41 \times 5{\cdot}108 \sin 80° \ 31' = 79{\cdot}94\ \text{A.}^3$; this results in an increased density of 6·569 gm./c.c. This increase in volume on oxidation causes the films of oxide to buckle and crack with the production of small crystals, so that there is always a possibility of oxygen reaching the copper surface.

From a consideration of these results and those of Garner and Stone, we suggest that the following theory might explain, in part, the difference between the reduction of copper by hydrogen and by carbon monoxide at low temperatures, and also account for some, if not all, of the specific effect of hydrogen in producing an activated copper.

The heats of reduction of copper oxide by hydrogen and carbon monoxide are approximately equal, but the thermal conductivity of hydrogen is about seven times that of carbon monoxide. In the case of reduction by hydrogen, the heat generated is rapidly removed from the reaction zone because of the high conductivity of the hydrogen, and the high temperature at these points is not maintained for a sufficient period of time to allow extensive migration of the copper atoms to form large crystals. A porous matrix is therefore produced. Further, as the porosity of the copper is increased during the course of the reaction, the internal surface area increases, thus augmenting the cooling effect and encouraging the formation of a spongy structure.

In the case of reduction by carbon monoxide, only when the copper oxide is in a finely divided state and separated by spacings sufficiently large to facilitate the entry of carbon monoxide into the intercrystalline structure can reduction be carried out at a rate similar to that obtaining with hydrogen. This reduction is most probably accompanied by a recrystallization of the copper into a compact metallic structure, the cooling effect being much less owing to the poorer conductivity of carbon monoxide. This consequent decrease in surface area is responsible for the lower catalytic activity of the resulting

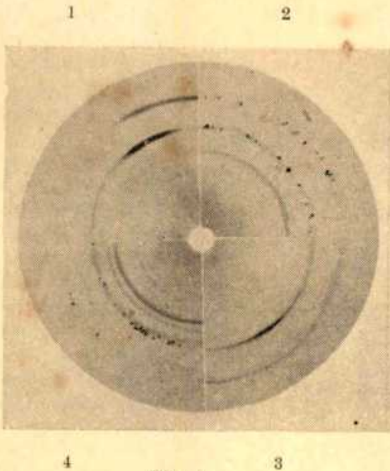

Fig. 1

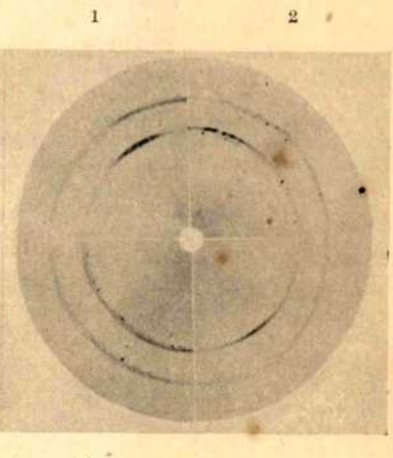

Fig. 2

Fig. 1. X-RAY PHOTOGRAPHS OF QUADRANTS 1 AND 3 ORIGINAL BRIGHT COPPER SHEET; QUADRANTS 2 AND 4 OXIDIZED COPPER SHEET. COPPER K_α RADIATION, $D = 2$ CM.

Fig. 2. X-RAY PHOTOGRAPH OF QUADRANTS 1 AND 3, ORIGINAL BRIGHT COPPER SHEET; QUADRANTS 2 AND 4, HYDROGEN REDUCED COPPER SHEET AFTER OXIDATION. COPPER K_α RADIATION, $D = 2$ CM.

copper. Following a second oxidation, the reduction with carbon monoxide proceeds with difficulty as the intercrystalline spaces are smaller and the penetration of the carbon monoxide does not occur so readily.

Comparing the crystal size of the activated copper and that of the original rolled sheet, it can be seen that the essential difference between an active and an ordinary copper is not primarily one of crystal size, but of porosity. Thus we suggest that hydrogen reduction under carefully controlled conditions produces an activated copper because the breakdown of oxide crystals occurs without extensive migration of the metallic atoms, and a spongy copper matrix is 'frozen' into position. When carbon monoxide is used, the heat generated is not conducted away from the zone of reaction so rapidly, and recrystallization occurs, with a consequent decrease in the intercrystalline spaces, and the formation of a less porous metal, which becomes increasingly difficult to penetrate with the CO molecule.

We wish to thank the directors of Messrs. Courtaulds, Ltd., for permission to publish this note.

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EFFECT OF GAMMA- AND X-RAYS ON DILUTE AQUEOUS SOLUTIONS OF ACRYLONITRILE

By Dr. F. S. DAINTON
Dept. of Physical Chemistry, Cambridge

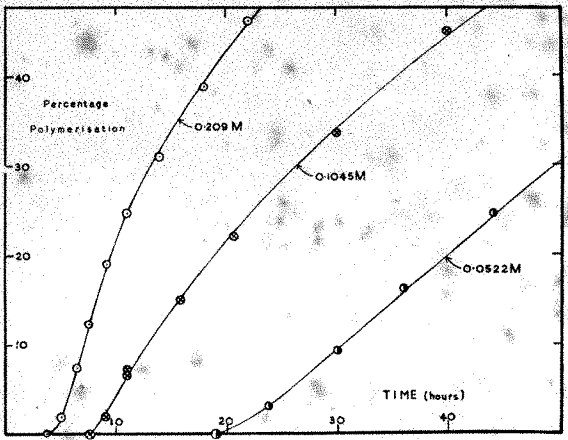
THE immediate effect of the absorption of high-energy radiation (α-, β-, γ- and X-rays, fast protons, deuterons, etc.) by water is the ejection of electrons from the water molecules lying along the tracks of the rays. There has been much discussion concerning the mechanism of the chemical changes which occur in water or dilute aqueous solution as a result of this 'primary radiochemical act'. Many of the investigations[1] have been concerned primarily with measurement of the ion pair yield (M/N is number of product molecules formed or reactant molecules decomposed per ion pair), and for such purposes it was sufficient to regard the radiation as producing 'activated water'[2], an unspecified intermediate capable of bringing about the observed changes and formed in amounts proportional to the dose. Recent reconsideration of the types of chemical reactions undergone by the solutes has led to the view, proposed by Weiss and now widely held[3], that the activated water consists of a hydrogen atom and hydroxyl radical, formed possibly by direct dissociation of water, or by electron capture and ion breakdown processes such as

$$\begin{gathered} H_2O^+ + e \rightarrow H^\cdot + -OH, \\ H_2O^+ \rightarrow H_{aq}^+ + -OH, \\ H_{aq}^+ + e \rightarrow H^\cdot. \end{gathered}$$

In order to test this view, it was decided to investigate whether types of reaction known to be brought about by neutral entities such as $H^\cdot$ or $-OH$, but unaffected by high concentrations of hydrogen or hydroxyl ions, could be induced in dilute aqueous solution by irradiation with X- or γ-rays. To obtain reaction times of reasonable length with the X- and γ-ray sources commonly available, it is necessary to use a reaction for which it is likely that $M/N \gg 1$. It was felt that a polymerization chain-reaction would be particularly suitable. The monomer selected was acrylonitrile, the polymerization of which in aqueous solution can be initiated by hydroxyl radicals generated either by the reaction[4],

$$Fe_{aq}^{++} + H_2O_{2_{aq}} \rightarrow Fe_{aq}^{+++} + OH_{aq}^- + -OH,$$

or by the photolysis by light of wave-lengths greater than 3000 A. of $H_2O_{2_{aq}}$[5]. Moreover, work on the polymerization sensitized by hydrogen atoms of vinyl compounds in the gas phase[6] suggests that hydrogen atoms in water should also initiate the polymerization of this type of solute. On the other hand, we have found air-free aqueous solutions of acrylonitrile containing high concentrations of hydrogen and hydroxyl ions ($N/2$ sodium hydroxide or sulphuric acid) to be stable for indefinite periods. The experiments outlined below, and of which full details will be published elsewhere, were therefore carried out. The results provide additional evidence for the formation of hydrogen atoms and hydroxyl radicals in water irradiated by X- and γ-rays.



POLYMERIZATION OF ACRYLONITRILE IN DILUTE AQUEOUS SOLUTION AT 20° C. SOURCE: 600 MC. RADIUM IN PLATINUM CYLINDER. RADIATION: γ-RAYS, 0·2406–1·761 MEV. ~ $3 \cdot 6 \times 10^9$ QUANTA CM.^{2} SEC.$^{-1}$ AT 1 CM.

The glass reaction cell, of 20-ml. capacity and with a central cavity into which the radiation source could be closely fitted, was filled with the solution of the monomer in de-aerated water and precautions taken to exclude air. The source (600 mC. radium in a platinum cylinder) was introduced for allotted time intervals, and the extent to which polymerization had occurred was determined by separating the precipitated polymer (either by filtering or centrifuging), washing with methanol and drying at 70° C. to constant weight. Results obtained in this way are given in the table, and some of the percentage polymerization-time curves shown in the accompanying figure. In each run there was an interval before the development of turbidity, which was the first sign of the polymerization. The reaction was also induced by X-rays from an industrial radiography unit operating at 10 mA. and 200 kV., but quantitative measurements have not yet been made.

The data given in the table indicate that, with a γ-ray source, the reaction is of second order with respect to the monomer concentration, and independent of source strength. The ion pair yield (M/N) is at least 10^4 for the 600 mC. source at the highest concentration used, and varies inversely with source

Source strength	Approximate dose-rate*	Monomer concentration	Percentage polym. per hour at steady rate	Second order rate constant × 10^4	Turbidity time
600 mc.	40 r. min.$^{-1}$	0·209 *M.*	4·05	5·4 l.mole^{-1} sec.$^{-1}$	3·7 hr.
„	„	0·1045 *M.*	1·95	5·2 „ „	8± 0·4 „
„	„	0·0522 *M.*	1·07	5·7 „ „	19± 1 „
„	„	0·178 *M.*	3·49	5·45 „ „	3·4 „
1200 mc.	80 „	„	3·7	5·8 „ „	1·95 „

* Calculated as 78 r. min.$^{-1}$ at the surface of the source, a value which agrees with ionization measurements at 3·75 cm. from this source.

strength. These results may be accounted for by assuming that the chemically significant primary act in these experiments is†

$$H_2O \overset{\gamma}{\rightsquigarrow} H^{\cdot} + -OH, \qquad (1)$$

and that the polymerization chain is initiated by the products of this reaction, that is,

$$H^{\cdot} \text{ or } -OH + m_1 \rightarrow m^*_1, \qquad (2)$$

propagated by

$$m^*_j + m_1 \rightarrow m^*_{j+1}, \qquad (3)$$

and terminated by interaction with a hydrogen atom or hydroxyl radical

$$m^*_j + H^{\cdot} \text{ or } -OH \rightarrow m_j. \qquad (4)$$

Chain transfer has been disregarded because it would not affect the rate of monomer consumption, and conceivable chain-transfer reactions with water are appreciably endothermic. Chain termination by interaction of growing chains in pairs is eliminated since it leads to a dependence of the rate on source strength and monomer concentration which has not been observed; it would be first order if all the hydrogen atoms and hydroxyl radicals are removed by reaction and none by re-combination, but 1·5th order if reaction 2 is slow compared with recombination of hydrogen and hydroxyl. Confirmation or otherwise of reaction 4 as the chain-ending process would have been possible from measurements of the molecular-weight distributions at different source strengths, since on the above scheme the chain length ($= 2\ k_2\ k_3\ m_1{}^2/k_4\ R$, where R is the rate of production of radicals in reaction 1) should decrease with increase of source strength. Unfortunately, the samples essential for these determinations did not survive transit, but it is hoped to test this point in the future.

It is of interest that Baxendale, Evans and collaborators[7], in a recent study of the polymerization of methyl methacrylate in aqueous solutions initiated by hydroxyl radicals produced by the Fe^{++}/H_2O_2 reaction, find the predominant mode of chain termination to be in pairs. However, at high initiator concentrations, deviations from their kinetics are found ". . . due to termination by the OH radical . . ." (ref. 7, p. 680). If, as seems likely, a similar effect would be observed in the polymerization of acrylonitrile solutions when the Fe^{++}/H_2O_2 catalyst is used, then it must be presumed that the hydrogen atoms and hydroxyl radicals formed in the solution irradiated by γ-rays are unevenly distributed throughout the system. Such high local concentrations would be expected along the tracks of the fast secondary electrons released by the radiation, and it is of interest that, in the case of X-rays, Lea (*op. cit.*, ref. 3, p. 52) has advanced other evidence for this type of radical localization.

The cause of the induction period (that is, turbidity time) is not yet known. Bacon and Evans *et al.*[8] have demonstrated that traces of oxygen lengthen the induction period in reduction activated polymerization of aqueous acrylonitrile solutions; but in our experiments great care was taken to exclude oxygen. The observed dependence of the turbidity time on monomer concentration and source strength (column 6 of the table) can readily be accounted for on the kinetic scheme proposed, provided it is assumed that the (unknown) inhibitor is destroyed by reaction with either or both of the products of reaction 1, as well as by reaction with growing polymer chains.

I am greatly indebted to Dr. N. Miller for frequent discussions and for his help, without which these experiments could not have been brought to the present stage, in the limited time available; to the National Research Council of Canada and the Ministry of Supply for hospitality and facilities; and to Dr. D. E. Lea for discussion.

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† Following American practice, the symbol $\rightsquigarrow$ in radiation chemistry will be taken to have a significance parallel to $\xrightarrow{h\nu}$ in photochemistry. See Burton, ref. 3.

[1] For a review of these effects, see Allsopp, *Trans. Farad. Soc.*, **40**, 79 (1944).

[2] Ref. 1, p. 84.

[3] See, for example, Weiss, *Nature*, **153**, 748 (1944); Lea, "Actions of Radiations on Living Cells" (Cambridge, 1946); Burton, M., address to spring meeting of the American Chemical Society at Atlanta City (1946), to be published.

[4] Baxendale, Evans and Park, *Trans. Farad. Soc.*, **42**, 155 (1946).

[5] Dainton, to be published.

[6] See, for example, Melville, *Proc. Roy. Soc.*, A, **163**, 511 (1937).

[7] Baxendale, Evans and Kilham, *Trans. Farad. Soc.*, **42**, 668 (1946). Baxendale, Bywater and Evans, *ibid.*, p. 675.

[8] Bacon, *Trans. Farad. Soc.*, **42**, 145 (1946); also ref. 4, p. 163–65.

HYPER- AND AVITAMINOSIS IN MICRO-ORGANISMS

By Dr. M. N. MEISSEL

Institute of Microbiology, Academy of Sciences of the U.S.S.R., Moscow

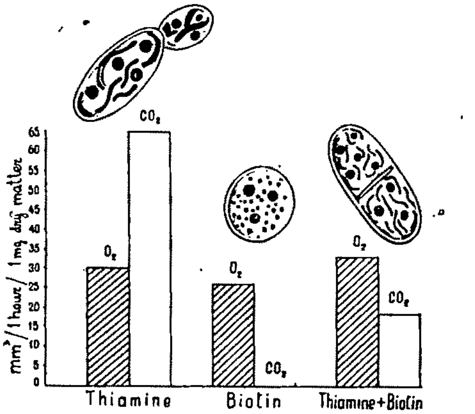
THE influence of vitamins on micro-organisms is usually estimated according to their accelerating effect upon the growth-rate of micro-organisms. However, cases are known in which some morphogenetic or physiological effects are clearly observed without any visible influence upon the growth-rate. On the other hand, increased growth-rate of the cells cannot always be considered as being due to the presence in the culture of a complete set of the vitamins necessary for normal development. Our morphological and physiological investigations of micro-organisms have shown them to be highly susceptible to changes in vitamin supply.

It has been found that the absence of certain vitamins necessary for normal development of the micro-organism may, nevertheless, result in a great increase of the yield. But after some days, because of insufficiency of their protoplast, the cells begin to die and the culture may be completely lost. The data presented below illustrate this point.

The yeast-like fungus *Endomyces magnusii* needs for normal development on Reader's synthetic medium (in which vitamin-free casein hydrolysate is used as a source of nitrogen) chiefly two vitamins namely, thiamine and biotin. Thiamine may be replaced by 4-methyl-5-oxyethyl-thiazole (vitamin thiazole). Each of these vitamins activated to some extent multiplication of this organism. When applied together, they lead to a great increase of yield[1]. If only thiamine or vitamin thiazole was added to the synthetic medium, the cells of *Endomyces magnusii* accumulate glycogen, volutin and this vitamin also. Cytological observation shows that the nuclei of this organism are enlarged and the chondriosomes are much hypertrophied. Since the features just mentioned are characteristic for the development of this fungus in relatively anaerobic conditions, we have termed this type of cell as the anaerobic or fermentating one[2]. Physiological tests showed that the culture grown in the presence of thiamine possessed the power of fermentation energy five to eight times as large as that in the culture grown in the absence of thiamine. It is of interest to note that the re-organisation in question is taking place in the presence of thiamine even in the aerobic condition, when the fungus is cultivated on the surface of the solid medium[3]. Accumulation of thiamine under these conditions amounts to 120–150 mgm. per gm. of dry material. Such a condition of *Endomyces magnusii* cells may be considered as a thiamine-hypervitaminosis, since the morphological and physiological features of the culture are very different when it is grown on the medium containing the complete set of vitamins. They will be described later, in connexion with a consideration of the combined influence of thiamine and biotin.

If biotin only is added to Reader's synthetic medium, the culture grows for two or three days and then dies off. The cells are spherical. Their protoplasm is heavily vacuolated and completely lacks glycogen and volutine. The chondriosomes are small and dust-like. Such a culture is not capable of fermentation to any noticeable extent and practically lacks thiamine. From the third day onwards, very intensive plasmolysis, coagulation, and necrobiosis of the protoplast take place. The great majority of the cells die off, and then serve as a substrate for single developing cells. There is every reason to interpret this picture as a thiamine-avitaminosis exaggerated by one-sided activation of multiplication, induced under the influence of biotin. Finally, if the medium contains both thiamine and biotin, the whole mass of the culture is extraordinarily increased. All the cells are alive, and elongated in shape. Their protoplasm is well developed, with a large number of fat inclusions. Only small amounts of glycogen and volutin are present. Thin rod-like or thread-like chondriosomes are scattered throughout the cytoplasm. These cultures are characterized by very high consumption of oxygen and weak, although quite measurable, power of fermentation. Such a type almost coincides with the normal culture, grown on the natural solid medium, for example, on the wort-agar medium, and may be designated as a normal aerobic or respiratory one. In the accompanying diagram data are given on the intensity of fermentation and oxygen consumption in cultures grown under conditions of different vitamin supply.

Pathological avitaminous conditions are also readily produced in representatives of the genus *Saccharomyces* when the normal vitamin supply necessary for development breaks down. In this case the depression is especially marked in the absence of pantothenic acid and thiamine.



CYTOLOGICAL APPEARANCE, RATE OF CARBON DIOXIDE PRODUCTION AND OXYGEN UPTAKE BY THE CELLS OF *Endomyces magnusii* GROWN ON SYNTHETIC MEDIA CONTAINING VARIOUS VITAMINS

The conclusion to be drawn from the data presented above is that the vitamin complex necessary for the normal development of micro-organisms is in many cases more than enough for quite intensive growth of the cells. It may well be that intensively growing culture lacking any one factor even of minor importance will show some kind of biological insufficiency. Therefore, there is no reason to regard the intensive growth-rate of the culture as a reliable means for determining the growth factors necessary for normal development of micro-organisms. An incomplete set of the growth factors breaks up their interregulating influence and may lead to extreme one-sided activation of some cell functions; the latter, in turn, gives rise to development of hyper- and avitaminosis.

[1] Meissel, M., Trofimova, N., and Lyssovskaya, N., *Microbiology (U.S.S.R.)*, 14, 191 (1945).

[2] Meissel, M., *Microbiology (U.S.S.R.)*, 8, 381 (1939).

[3] Meissel, M., *Microbiology (U.S.S.R.)*, 10, 649 (1941).

CARCINOGENIC ACTIVITY OF PREPARATIONS RICH IN CHOLESTEROL

By DR. I. HIEGER

Chester Beatty Research Institute, Royal Cancer Hospital (Free), London

AN earlier report from this Institute[1] recorded that carcinogens had been detected in fractions from human tissues (liver, lung, kidney and muscle) obtained from cancerous and non-cancerous subjects. The activity was concentrated in the cholesterol-rich (*c.* 85 per cent) fraction of the unsaponifiable part of the tissue, and it was suggested (*loc. cit.*, p. 666) that cholesterol itself may not be inert in the carcinogenic process. The further data now available and tabulated below (Table 1) are not incompatible with the hypothesis that cholesterol itself may be carcinogenic, although the alternative view that preparations rich in cholesterol may contain small quantities of an unknown but potent carcinogen cannot yet be excluded; very pure cholesterol prepared chromatographically by Dr. Shoppee is now under test in this Institute.

TABLE 1

*C*57 strain mice	Initial No. of mice	No. of sarcomas (at site of injection)
Materials tested		
Commercial cholesterol	43	5
9 cholesterol-like compounds (cholesterylene, 7-dehydrocholesterol, etc.)	100	0
Cholesterol-rich fractions from mammalian (cattle) liver	30	0
Commercial cholesterol + certain animal and vegetable oils	60	0
,, ,, + cod liver oil	10	3
,, ,, + unsaponifiable fractions of human liver	20	0
,, ,, + sesame oil	10	1
,, ,, refluxed with KOH and alcohol	20	0
Unsaponifiable fraction of human bile and gall bladders (cholesterol content *c.* 90%)	40	1
,, ,, ,, cream (cow's milk) (cholesterol content *c.* 90%)	10	1
,, ,, ,, rat tumour tissue	15	0
Lard alone	10	0
Unsaponifiable fractions of human tissue (cholesterol content 90% and downwards)	227	3
	595	14
Mixed stock mice		
Human liver, unsaponifiable fractions (cholesterol content 90% and downwards)	260	3
Unsaponifiable fraction of gall stones	10	0
M.R.C. strain mice		
Commercial cholesterol	21	2

The technique of testing was described in detail in the paper referred to above; in brief, the essential features were: (1) The material for test were dissolved in lard at 15 per cent concentration (except for the sesame oil experiment). (2) Injection in mice were made subcutaneously in the flank (0·1–0·4 c.c.) at fortnightly intervals; injections were suspended as long as a reservoir of material could be detected by touch. If groups of mice died early in the experiment, they were replaced so as to ensure that a satisfactory number of animals survived long enough in all tests.

The small number of solvent controls (10 mice) need cause no concern, for all the negative results with *C*57 mice (namely, 595 − 14 = 581) constitute the controls on the solvent (lard). More than 300 controls on lard have been carried out on mixed stock mice without producing a single sarcoma[1,2]. One must mention, however, that a closely allied species, the rat, behaves differently, for evidence is accumulating that it is liable to sarcoma production by the subcutaneous injection of a variety of fatty substances of animal and vegetable origin.

The latent periods for the different groups of tumours, that is, those produced by commercial cholesterol in lard only and those produced by the other preparations, show much overlap (Table 2).

TABLE 2. LATENT PERIOD OF TUMOURS IN TABLE 1 (MONTHS)

Commercial cholesterol in lard	U.F.* of bile + lard	Commercial cholesterol + sesame oil	Commercial cholesterol + cod liver oil + lard	U.F. of human tissue fractions + lard	U.F. of cream + lard
11	29	14	20	18	13
23			23	19	
13			25	19	
20				16	
22				12	
22				16	
23					

* U.F. = unsaponifiable fraction.

The total production of sarcomas in mice at the site of injection by substances of biological origin is given in Table 3, which represents the chief results of experiments in progress in this Institute up to the time of writing[1,2,3].

TABLE 3

	Material	Total sarcomas
1.	Unsaponifiable fraction of cow's milk (experiments of Prof. E. L. Kennaway)	1
2.	Unsaponifiable fraction of cream (cow's milk)	1
3.	Commercial cholesterol	11
4.	Unsaponifiable fraction of human tissues (liver, lung, kidney, muscle) and bile from cancerous and non-cancerous subjects	31
	Ether extract (that is, saponifiable) of human cancerous liver	2
6	Ether extract (that is, saponifiable) of mouse mammary tissue	1

The foregoing data now suggest three possibilities:

(1) That cholesterol is, in fact, a slow carcinogen, particularly in the presence of other facilitating lipids, and in the absence of inhibiting factors.

(2) That commercial cholesterol (cholesterol content high but uncertain, of the order of 98 per cent perhaps) contains a small amount of an unknown but potent carcinogen; and that cholesterol-rich fractions from human tissues (liver, lung, kidney and muscle), from cow cream, from cattle brain and spinal cord, and from human bile all contain, in addition to cholesterol, the unknown carcinogen.

(3) The operation of unknown factors (for example, important variations of susceptibility of the experimental mice).

This work was supported by grants-in-aid from the British Empire Cancer Campaign, the International Cancer Research Fund, the Anna Fuller Fund and the Jane Coffin Childs Memorial Fund for Medical Research.

Note added in proof. At the time of writing there are still a few surviving mice in the experiments described in the tables. Thus the total of tumours shown is a minimum figure and may have to be slightly raised when all the mice are dead.

[1] Hieger, I., *Cancer Res.*, 6, 657 (1946).
[2] Hieger, I., *Amer. J. Cancer*, 39, 496 (1940).
[3] Hieger, I., *Science*, 93, 262 (1941).

FORTHCOMING EVENTS

Wednesday, August 27—Wednesday, September 3

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Dundee).—109th Annual Meeting.

Wednesday, August 27

In the Caird Hall, City Square, Dundee, at 8.30 p.m.—Sir Henry Dale, O.M., F.R.S.: "Science in War and Peace" (Presidential Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT PHYSICISTS (2) in the Radiotherapy Service, and an INSTRUMENT MAKER—The Secretary, South Wales and Monmouthshire Joint Cancer Committee, County Hall, Newport, Mon. (August 30).

PRINCIPAL OF THE IPSWICH SCHOOL OF TECHNOLOGY—The Chief Education Officer, 17 Tower Street, Ipswich (August 30).

LECTURER IN PHYSICS, and a LECTURER IN CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (August 30).

RESPONSIBLE LECTURER IN PHYSIOLOGY (Senior Assistant)—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (August 30).

UNIVERSITY LECTURER IN MATHEMATICS, with special qualifications in Statistics—The Secretary, Appointments Committee of the Faculty of Mathematics, Trinity College, Cambridge (August 30).

ASSISTANT MASTERS in H.M. Dockyard Schools (one each at Portsmouth and Chatham)—The Director, Education Department, Admiralty, London, S.W.1 (August 30).

LIBRARIAN, and an ASSISTANT LIBRARIAN, at the Coventry Technical College—The Director of Education, Council House, Coventry (August 30).

SENIOR ASSISTANT IN ELECTRICAL ENGINEERING in the Bournemouth Municipal College—The Education Officer, Town Hall, Bournemouth (August 30).

Lecturer in Mechanical Engineering—The Registrar, Merchant Venturers' Technical College, Unity Street, Bristol 1 (August 30).

Lecturer in Mechanical Engineering—The Principal, Dudley and Staffordshire Technical College, Dudley (August 30).

Senior Assistant in Civil Engineering, a Senior Assistant in Electrical Engineering, a Responsible Lecturer in Mechanical Engineering, and a Lecturer in Electrical Engineering—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (August 30).

Assistant Bacteriologist and Lecturer in Bacteriology—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (August 31).

Vice-Principal and Senior Lecturer in Agriculture, an Assistant Lecturer in Agriculture with special knowledge of Farm Machinery, an Assistant Lecturer in Agriculture with special knowledge of Dairying, and a Senior Instructress in Rural Domestic Economy—The Principal, Yorkshire Institute of Agriculture, Askham Bryan, York (September 1).

Head of the National Foundry College being established to provide for technical education and research in connexion with the Foundry Industry (Ferrous and Non-Ferrous)—The Clerk to the Board of Governors, National Foundry College, at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton (September 6).

Educational Psychologist—The Secretary for Education, County Buildings, Shrewsbury (September 6).

Teacher of Physics and Radio for day and evening classes—The Secretary, Norwood Technical Institute, Knights Hill, West Norwood, London, S.E.27 (September 6).

Lecturer for advanced teaching and the supervision of research in organic chemistry—Sir Ian Heilbron, F.R.S., Royal College of Science, Imperial College of Science and Technology, South Kensington, London, S.W.7 (September 12).

Assistant Lecturer in Pure Mathematics—The Registrar, The University, Manchester 13 (September 13).

Lecturer in Metallurgy—The Registrar, The University, Leeds 2 (September 15).

Lecturer in Physics—The Principal, Heriot-Watt College, Edinburgh (September 15).

Lecturer in Physiology—The Secretary and Bursar, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (September 15).

Inspector under the Dangerous Drugs Acts—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1958 (September 16).

Senior Principal Scientific Officer in the Radio Department of the Royal Aircraft Establishment, Farnborough, Hants, under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1962 (September 18).

Tutorial Studentships in (*a*) Physics, and (*b*) Mechanical Engineering—The Secretary, King's College, Strand, London, W.C.2 (September 20).

Lecturer in Physics—The Principal, Royal Holloway College, Englefield Green, Surrey (September 20).

Singhanee Lecturer in Fuel Technology—The Registrar, University of Bombay, Bombay 1, India (September 29).

Geologists, and Senior Geologists, in the Geological Survey of Great Britain—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1963 (September 30).

Assistant Conservators of Forests (2) for the Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Forests' (October 1).

Geneticist (Senior Research Officer or Principal Research Officer), a Silviculturist (Senior Research Officer or Principal Research Officer), a Chemist (Research Officer or Senior Research Officer), and a Plant Pathologist (Research Officer or Senior Research Officer), at the new Wattle Research Institute attached to the Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 30).

Artist-Secretary for Pathological Museum—The Dean's Office, St. Thomas's Hospital Medical School, London, S.E.1.

Head of the Mathematics Department—The Principal, Huddersfield Technical College, Huddersfield.

Fish Expert by the Iraqi Government Ministry of Economic Affairs—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.14573.

Lecturer in Physics at the Leeds College of Technology—The Director of Education, Education Department, Calverley Street, Leeds 1.

Lecturer in Biology, with special knowledge of Zoology—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15.

Head of the Electrical Engineering Department—The Registrar, Portsmouth Municipal College, Portsmouth.

Senior Assistants in the Departments of Civil and Mechanical Engineering, Electrical Engineering, and Physics—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Lecturer in the Department of Biochemistry—The Secretary, The University, Edinburgh.

Demonstrator in the Department of Pharmacy—The Secretary, Royal Technical College, Glasgow.

Laboratory Technician (Grade B) in the Physiology Department, and a Laboratory Technician (Grade C) in the Chemistry Department—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

Graduates in Physics or Chemistry to conduct research into problems connected with the manufacture of pottery—The Director of Research, British Pottery Research Association, Queen's Road, Penkhull, Stoke-on-Trent.

Laboratory Technician (Grade B) in the Area Pathological Laboratory—The Medical Officer of Health, Municipal Buildings, Middlesbrough.

Lecturer or Assistant Lecturer in Zoology—The Registrar, University College, Exeter.

Graduate in Agriculture with organising ability and experience both of teaching and practical farming, as Headmaster of the Jamaica School of Agriculture—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Senior Assistant in the Department of Mechanical and Automobile Engineering, Doncaster Technical College—The Chief Education Officer, Education Office, Wood Street, Doncaster.

Graduate with First- or Second-Class Honours or Higher Degree in Chemistry, and a Graduate with special qualifications in Engineering—The Principal, Mining and Technical Institute, Neath.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

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Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 816, Vol. 240: The Determination of the Depths and Extinction Coefficients of Shallow Water by Air Photography using Colour Filters. By J. Grange Moore. Pp. 163–217 + 15 plates. (London: Cambridge University Press, 1947.) 22*s*. [133

South-Eastern Naturalist and Antiquary: being the Fifty-first Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Fifty-first Annual Congress held at Tunbridge Wells, 1946. Pp. xxxvi + 64 + 5 plates. (Guildford: Hon. Sec., H. M. Mountford, 23 Mountside, 1946.) 5*s*. net. [133

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Carnegie Trust for the Universities of Scotland. Forty-fifth Annual Report (for the Year 1945–46) submitted by the Executive Committee to the Trustees on 10th February 1947. Pp. iv + 64. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1947.) [133

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SWORDS INTO PLOUGHSHARES

THE British Association was holding its annual meeting in Dundee in 1939 when war was declared. Appropriately enough, the Association is now holding its first full-time post-war meeting in the same city. It was therefore a wise decision on the part of the Council of the Association to arrange that the general theme at the meeting should so far as possible be "Swords into Ploughshares". The contribution of science to human progress is mainly positive and constructive, no matter whether it be fundamental or specifically applied; most men of science would wish that it were completely so. But in warfare of this modern age men of science have their part to play, distasteful though it may prove to be. Yet scientific research carried out as part of the strategy of war almost invariably yields results which, despite the fact that they might be destructive in war-time application, present much useful material and data for the positive pursuits of peace-time. This is well brought out in the addresses of the presidents of the various sections of the Association, but nowhere more so than in Sir Henry Dale's general presidential address entitled "Science in War and Peace" (p. 280).

In facing realities we must agree that the world is not yet at peace, neither is it free from the threat of further conflagration, perhaps even on a world-wide scale. It follows that though every effort towards world peace must be made, it would be foolish during present troublesome times to fall into a state of lethargy and unpreparedness. So some scientific research, especially that dealing with certain aspects of atomic energy, must even now, and perhaps for some time to come, be carried on under the ban of official secrecy. Feeling is high these days, and concern is often expressed that military secrecy might take the place of former industrial interests in slowing up the free flow of ideas which are essential to the smooth progress of scientific endeavour. But at present men of science must face the fact that some secrecy is inevitable, and this makes it all the more imperative, therefore, that they themselves should strive to bring before each other and above all before the general non-scientific public the many beneficent aspects of science. It is doubtful if even men of science themselves fully appreciate the general trend of public opinion concerning science, especially since the advent of the atom bomb. Public opinion, even in high places, if sometimes not well informed, is nevertheless expressed and sometimes acted upon. Some fear that science might become more and more a tool for enforcing one or another political credo and for use in diplomatic intrigue. It is for men of science to prevent this so far as they possibly can. Science must play an important part in international relations; but, at any rate during times of peace, let that be a constructive one. We already have it in the United Nations Food and Agriculture Organisation and it is developing in the United Nations Educational, Scientific and Cultural Organisation.

Yet with all this, opinion is still divided, and even among some scholars and students there are powerful 'anti-science' groups; men who should know better have been heard to express alarm at the march of science and demand the fettering of science and scientific workers. This must not be ignored, and it is therefore best countered by men of science themselves telling the world (so far as they are allowed) of their work, stressing especially the value of their discoveries to man and the profound importance of the impact of science on a modern human society.

Sir Henry Dale, in his presidential address, reiterated the aims of the Association in providing a forum for discussing the interests of science, and its proper place in the life of the community, of the nation and of the world. The word 'proper' is more significant to-day than it has ever been, for there is still much misunderstanding among non-scientific people, even up to the political level, about things scientific. This must be rectified, and it is mainly through such agencies as the British Association and by means of well-documented and written general scientific publications that this can be done.

As Sir Henry said, the concern of science with war was abnormal. Critics tend to forget the conditions under which men of science, like all other members of this and other nations, were working during the War. Most men of science then had a very definite and immediate aim; and all other things were made subservient to that. Working on those projects which aimed at destruction, they were well aware of what they were doing. Sometimes it must have demanded greater courage to carry on research in such circumstances than to abandon it on the grounds of conscience. Those same men of science in days of peace will be able to present their findings to humanity for the good of all; but that depends on national and international goodwill and above all on a true estimate and appreciation of science by the non-scientist. War-time discoveries may be applied, or will certainly lead, to other discoveries which will be for the good of man, finding himself as he does in social conditions becoming more and more affected by scientific achievement.

A week of meetings of the British Association is naturally more than an exposition of recent scientific achievement, though, even if it were narrowed down to this, since such achievement has now to be transferred from war-time use to peace-time applications, there is much work ahead—enough to change the entire pattern of social life, as the examples chosen by Sir Henry Dale serve to show. All listeners to, or readers of, this erudite summary of achievement will be grateful to Sir Henry for a choice wisely made; for no one but the most biased can, after digesting such fare, ignore the inestimable benefits that even war-time science must ultimately bestow on mankind, given the necessary atmosphere of peace and goodwill.

But Sir Henry also issues very pertinent and timely warnings to research workers themselves. For example, the distinction between war-time scientific research (the concentration of nearly all one's thoughts and efforts on practical problems the rapid solution of which was the sole objective) and peace-time research which demands taking a long-range view with the first care of extending fundamental knowledge unconstrained by aim at any practical objective, must be taken to heart by all scientific research workers, especially those of the younger generation who have had their first experience of research work in war-time laboratories.

Older research workers, also, should take to heart Sir Henry's plea that they should not be too ready to assume that their best service to science still lies in planning and organising, or in bringing scientific affairs to bear upon policy. Though in a world of planning men of science must have their say, and in international deliberations, both political and economic, the voice of science must be heard; in other words, though, as *Nature* has frequently demanded, men of science should be consulted and if desirable put into control where matters scientific are concerned, yet a sense of proportion must be brought to bear on this peace-time problem of transition so that it may be realized that the main work of the majority of our men and women of science must be carried out in the laboratories of fundamental research. The main aim must be the advancement of pure knowledge, the search for and exposition of the truth so far as scientific method can elucidate it. The material betterment of man's lot will, in the main, follow from this; in any event it is an ancillary aspect of a very noble calling.

AN ENCYCLOPÆDIA OF HUMAN GENETICS

Human Genetics

By Prof. Reginald Ruggles Gates. Vol. 1. Pp. xvi + 742. Vol. 2. Pp. vi + 743–1,518. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1946.) 2 vols., £3 15*s.* net.

THE rôle of the gene in the etiology of human defect and derangement is now widely recognized. In the medical curriculum a place for a course of instruction in genetics has been found. The dramatic discovery of the genetic nature of congenital hæmolytic disease has aroused among practitioners of medicine a keen desire to know more about this science, and they are asking for books which will give them the information and the guidance which they seek.

There are elementary text-books of high quality which adequately display and sufficiently illustrate genetic principles. There are monographs which deal with a particular organ, system or clinical entity and include references to most, if not all, instances of relevant genetic abnormality or abnormalities. Twenty-four years ago there appeared the very ambitious treatise of Baur–Fischer–Lenz, which attempted to include between the same covers all instances of genetic defect and derangement affecting each and every system of the human subject; and in 1929 what may be regarded as the forerunner of the book now under review, "Heredity and Man" by Prof. Ruggles Gates, dealing with the whole subject of the special genetics of man. These two did much to attract an interest in genetical science on the part of the anthropologist and the physician.

But developments in medical science and the more recent work on human genetics, together with the exceedingly rapid progress in genetical science generally, have outmoded all books written a decade or more ago. Teachers of genetics, among many others, have felt the need for an authoritative modern encyclopædic book of reference which would cover the whole field and which would lighten the burden of combing the vast and scattered literature for their illustrations and for the information on which they must base the advice for which they are so commonly approached.

Prof. Ruggles Gates has valiantly attempted to satisfy this need. The result of his long-sustained industry is a book which must attract the respect of all who are in a position to recognize the immensity and the difficulty of the task that he undertook. It is indeed a remarkable, a Herculean, performance. Its magnitude and comprehensiveness can perhaps best be measured by the size of the index, which occupies no less than 90 pages, and by the number of the references, some 5,500, to key papers and books.

As a book of reference these volumes must prove to be of the greatest usefulness. As a collector of pedigrees, Prof. Ruggles Gates must surely be unsurpassed, and to him much gratitude will be attracted through this service which he has rendered during the years of his retirement. But this is meant to be more than a book of reference. It is also a vehicle for the author's interpretation of recorded fact, for his views concerning the nature and cause of genetic phenomena. It is offered therefore as a text-book, and it is as such that its value must be assessed.

Prof. Ruggles Gates is a professional botanist and cytologist of high repute and an anthropologist of standing. He has made notable contributions to the advancement of these sciences. He is among the more prominent of eugenists. But his knowledge of human pathology and of clinical medicine is sufficiently limited to permit him to discuss their contents with an apparent ease which is not displayed by anyone as expert in these fields as is Prof. Gates in his own.

The geneticist with an adequate knowledge of clinical medicine, the medical specialist with a sufficient knowledge of genetics, who turns to this book for guidance based on a critical evaluation of the evidence recorded and dealing with a particular pathological condition in which he happens to be interested, may expect to be surprised, even shocked, by the author's lack of familiarity with the particular subject. How could it be otherwise, for it is highly doubtful if there exists any one man who is competent to deal in this way with the whole of medical genetics or, if it comes to that, with the whole of medicine, which in its growth has become fragmented into a multitude of specialties.

When the author is dealing with matters of which his knowledge has been derived from his own scientific activities, his analyses and summaries are precise, cogent and authoritative. But when he turns, as he commonly must, to matters of which his acquaintance is of the slightest, his commentaries are often hesitant, unsure, sometimes definitely erroneous and occasionally positively misleading.

This book should be regarded as a great storehouse of factual information to be used by such as seek recorded observations concerning the modes of inheritance of human defects and derangements, and as are themselves already competent to make use of what they find. It is for the specialists in the different branches of medicine who already have an understanding of modern genetic theory. As such the book is greatly to be welcomed, and for it the author is to be praised. F. A. E. Crew

MIRACLES

Miracles

A Preliminary Study. By C. S. Lewis. Pp. 220. (London: Geoffrey Bles, 1947.) 10*s*. 6*d*. net.

NOT being a trained historian, Mr. Lewis does not examine the historical evidence for 'miracles'; and having never experienced a 'miracle', he has no direct evidence to offer. But as a student of philosophy, he claims to discuss the previous questions, whether 'miracles' are possible at all, and if so, how probable they are, and how the occurrence of a 'miracle' may be proved. In his last three chapters he applies his reasoning to those miracles, acceptance of which is an article of belief for Christians. He defines a 'miracle' as an interference with Nature by super-natural power. If there is no such power beyond Nature, there can be no miracles. Those who think that nothing exists except Nature hold that Nature somehow maintains itself; though some admit that there was a beginning, and that some day "the clock will run down". The alternative is to regard Nature as derivative from some 'one thing', which is basic and original; which created and maintains; what most people call 'God'. The compromise, an indwelling and emergent God (p. 31)—like the other notion that Nature's elements, indeterminate themselves, conform to the 'law of averages'—does not reveal either basis or origin. The issue, therefore, is between 'naturalism' and supernaturalism.

Mr. Lewis argues that no account of the universe can be true unless it leaves it possible for our thinking to be a real insight. The validity of thought is essential, and it cannot be explained by irrational causes. Whereas Nature is quite powerless to produce rational thought (p. 37)—though it can inhibit it—rational thought enables us to alter the course of Nature, as we constantly and consciously do. Each rational thinker thus is—or includes—something independent of Nature, an "incursion" into Nature of supernatural reality—of a reason which exists absolutely on its own (p. 36), a "principle of organization which impels and develops" (p. 41); and this it can do, because Nature (as Heraclitus said) is "logical and congruous with our minds".

Occasionally, Mr. Lewis seems to make a similar claim for all sentient life (p. 165) and even for vegetable life (p. 135); and as to rational life his argument resembles the old principle *omne vivum e vivo*, which is still for physiologists a fact of observation, however firm their faith that it may be refuted some day.

What is demonstrable thus about logical thinking —about truth in all its forms—is true also about primary moral principles (p. 44). What is in question is not the fact that men make moral judgments, but the rightness of them; and rightness cannot result from non-moral events, any more than truth from irrational. Goodness, like truth, has its basis outside Nature. The same argument might be used about beauty, though Mr. Lewis does not concern himself with this aspect of the supernatural—this quality of the divine.

Thus a 'naturalist', whatever else in Nature he can explain, cannot account for himself, or for mankind, in these essential respects. To Mr. Lewis's argument, he can only oppose his profession of faith: "we do not know yet—but some day we shall—that thought can originate from the thoughtless, and life from the lifeless". This, however, is not science but dogma, and many 'naturalists' merely shelve the question. This inability has escaped notice because modern concentration on the perception and understanding of Nature by means of reason, without attention to that by which Nature is perceived and understood, has led to the 'naturalist' illusion that there is no such thing. From the special experts in experiment, untrained in logic and metaphysic, Mr. Lewis appeals to the mystics and philosophers of all ages (p. 109); regarding our present predicament as abnormal and perhaps transitory (p. 53).

From this first contention, that human rationality is in itself (by his definition) a 'miracle'—that the supernatural not only exists but also interpenetrates Nature—Mr. Lewis goes on to ask whether there are any other such interventions. At this point, Mr. Lewis's argument passes from general to particular, from the possibility of 'miracles' to the probability of the greater miracles of Christian belief; and inevitably from logic and metaphysic to historical evidence as to times and places. Not being (admittedly) a historian, Mr. Lewis does not see that criticism of one class of 'miracles' must be applicable to all, from the Incarnation, Joshua's prolonged daylight, and the Resurrection, to the 'calm' of Dunkirk. It is this which has made the most expert historians the most cautious in admitting 'miracles'; and they occur most freely in periods when critical skill was least. Christian theology itself, as Mr. Lewis has seen (p. 85), is one long protest against the misinterpretation of symbols inevitably inadequate.

If a 'miraculous' event is unique, as Nature is itself unique, historical proof is almost impossible. Mr. Lewis compares the recovery of a missing episode from a novel or a symphony: if what is found 'makes sense' of the whole composition, its genuineness becomes very probable, and Mr. Lewis devotes the rest of his book to this view. He might have followed the great theologians further. But appropriateness is not proof. John L. Myres

ONSLAUGHT ON A SUPERSTITION

The Royal Art of Astrology

By Robert Eisler. Pp. 296+17 plates. (London: Herbert Joseph, Ltd., 1946.) 18*s*. net.

For the convenience of astrologers "Whitaker's Almanack" for 1947 carefully records the "hour when the Sun enters each Sign of the Zodiac"; Eisler describes in his opening pages how rampant astrology is. He is obviously anxious to destroy this present "stale, superstitious residue", and perhaps his historical survey often forgets his own dictum that this once "glorious philosophical attempt" founded modern astronomy and cosmology (pp. 28, 262). He connects present astrology with "widespread intellectual destitution", and includes with it many pre-critical survivals, such as belief in the "spontaneous generation of life" or in "causes and effects" (pp. 11f, 260f).

Astronomy can forecast an eclipse; astrology can use astronomical calculations, but its own peculiar predictions from horoscopes about the War give Eisler a chance. Italy's entry was not foreseen: an unread message in the stars, however, is less damaging than a message misread. The stars were misread about Sweden, for some astrologers expected Hitler to attack her. Astrologers constantly predicted no war until there was one; then they constantly predicted its end before the finish came. Eisler deduces that modern astrologers try to please their clients by comforting predictions (pp. 21ff). Even if war-time predictions are not fair samples, they are significant. Some astrologers, fairness should add, affirm the old aphorism, the stars incline and do not compel: they impose temperament, not specific destiny. Astrology is vulnerable enough to make undiscriminating arguments unnecessary.

The zodiacal signs cannot derive their astrological significance from accumulated Chaldean and Egyptian experience, Eisler affirms, because they were originally unimportant (pp. 87–110). "Precession" provides "one of the most decisive arguments" against astrology by involving it in absurdities. Eisler notes a typical absurdity "in most modern text-books of astrology". A child born, or conceived, when a certain sector of the zodiac is rising has "Taurine" qualities. Aries is there now, but Taurus was there two thousand years ago, and left his power in it (pp. 110–22).

The stars and planets did inflict one stupendous consequence on men—a medley of beliefs in their presumed effects which determined astrological lore more than sober induction. Eisler uses modern research, the study of old astrological records, for example, to probe the growth of astrology. Inferences about astrological inferences may be mistaken; but Eisler's survey reveals the workings of the human mind and their astrological consequences. His onslaught seems to have precipitate consequences at times. He seems to ignore, for example, that Eudoxus and some others after him regarded the "spheres" as non-physical geometrical conveniences (pp. 33ff). He calls the "hypothetical 'attraction' " of Vitruvius the ancestor of Newton's "mythical 'force' of 'gravitation' ", though Newton did not regard "forces" as actual agents (p. 237).

If Mars derives his astrological reputation from his reddish hue, and Saturn, the "leaden planet", his from his "slow, constant movement", astrology has embodied some wild analogies. It embodies another, if those born under a slowly rising sign live long (pp. 103, 162f, 169). Eisler discusses many wild analogies that have suffused astrology. Imagination has grouped the stars into constellation-pictures, connected them with myths, and drawn astrological deductions. Scorpio, for example, indicates his influence by appearing in the horoscopes of Hitler and Mussolini, though Goethe and Horace had the same ascendant sign (pp. 102f). Historical evidence, Eisler replies to modern defenders, shows that the signs were not named *after* their actual effects had been observed (p. 115).

Tycho Brahe, Eisler says, clung to geocentric astronomy because a central earth is essential to astrological divination (pp. 210, 230). In 1653, Thomas Steele does not fear Copernicanism because astrology can use any valid system of calculation; for an extreme relativist to-day mathematical convenience decides between heliocentrism and geocentrism.

Interesting items include souls and stars, the egregious horoscope of Christ, the "houses" of the planets and the creation of the world, astrological disregard of the velocity of light, the adoption of Uranus as the patron of machinery, and, like odd grains of wheat in much chaff, some actual lunar effects.

There is no index—perhaps because there is so much to compile. The chapter headings, however, are reasonably good guides. Interesting plates and figures are explained in Chapter 33. The last chapter contains a useful bibliography—with comments by the author. Joshua C. Gregory

THEORY OF RADIO ANTENNÆ

Antennæ

An Introduction to their Theory. By J. Aharoni. Pp. viii+266. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 25s. net.

THE theory of radio transmitting and receiving aerials is by no means an easy branch of electromagnetism. Aerial theory forms the bridge between the theory of circuits and transmission-lines on one hand and the theory of wave-propagation in space (that is, space more or less free from boundaries) on the other. Aerial theory thus has to face the difficulties of both fields without the simplifications of either. Useful progress largely depends on knowing when, how and how far to permit infiltration of simplifications from both sides. Progress has not therefore been easy, and misunderstandings have been common. However, the widespread development of aerials for radar and radio communication during the War, sometimes along novel lines, has served to clarify the issues involved. The time is therefore ripe for setting down on paper connected accounts of the progress so far made in the development of aerials, and of aerial theory in particular.

This book is, for the most part, a connected account of aerial theory as it had appeared in the technical press before the curtain of war-time secrecy fell. The treatment is mathematical, and the book is scarcely suitable for readers who are not reasonably at home with a mathematical presentation. But the treatment is not academic. What is written seems to have been dictated, not by a desire to do mathematics, but by a desire to describe in mathematical language the basic physics of aerials that should be understood by any radio engineer whose job involves getting down to fundamentals. The book does not deal with elaborate, fancy, or novel aerial systems. It deals almost exclusively with fundamental theories of elementary aerials: the loop, the Hertzian dipole, the half-wave dipole, the full-wave dipole and dipoles of intermediate lengths.

It may be doubted whether the arrangement and subdivision of the book is as good as it might have been. The book is divided into only three chapters, of which the second consists of nearly sixty per cent of the whole. The reader is consequently apt to find that, before he has adequately reflected on one aspect of the subject, he is already engulfed in another. In spite of this, however, the arrangement is not confused, and there is no serious difficulty in finding what one wants from the table of contents. Whether the arrangement adopted places the simplest things first, and whether the approach used is always the simplest available are perhaps matters of opinion.

In each principal aspect of the subject the author has followed fairly closely the original papers that he quotes. For this there is much to be said, though a little more criticism in places would have been welcome. Hallen's treatment of the ends of an aerial is, for example, rather shaky, but the author reproduces Hallen's original argument with apparent confidence. Even so, however, it is very convenient to have Hallen's theory available in this book, since the original paper is in a somewhat inaccessible journal. In addition to Hallen's theory based on an integral equation for the current-distribution, the book includes Schelkernoff's theory based on a wave-guide treatment of the biconical horn, theories dealing with prolate spheroidal conductors, Brillouin's "back E.M.F." method for calculating input-impedance for aerials having prescribed current distributions, as well as the usual treatment of the polar diagram and the radiated power by the Poynting vector method.

Since the author seems to have set out to collect in book form mainly the standard papers on fundamental aerial theory, it would perhaps be unfair to criticize him for making no serious use of the concept of field impedance. Field impedance is equally applicable to transmission lines, to aerials and to wave propagation in space, and so is well suited for integrating all of these phenomena into a single picture. Consideration of field impedance leads one to regard the operation of a straight thin aerial somewhat as follows. Imagine a geometrical cylinder drawn coaxial with the aerial wire and having a radius equal to, say, the geometric mean of the radius and length of the aerial wire. Let this cylinder be terminated by planes through the ends of the aerial perpendicular to the wire, and consider the regions inside and outside the cylinder separately. Outside the cylinder the field may be thought of as that due to a prescribed sinusoidal distribution of current along the aerial wire, and on this basis the field impedance looking normally out of the cylinder may be calculated. Inside the cylinder, the field departs from that due to a sinusoidal distribution of current, especially near the aerial wire itself, and this is how the boundary conditions at the surface of the wire are satisfied. Inside the cylinder the field may be thought of as that in a concentric transmission line the inner conductor of which is the aerial wire and the outer of which is the geometrical cylinder; the impedance per unit length of the outer is that calculated from the field outside the cylinder as already described. This is quite a useful and flexible way of effecting the all-important link between the transmission line approach to aerials and the approach based on a prescribed sinusoidal current-distribution. In particular it explains why, in the conventional application of the back E.M.F. method, it is possible to integrate what is undoubtedly the wrong quantity along the aerial wire and yet get something extraordinarily like the right answer. The integral should in reality be taken along the outer of the concentric transmission line described above, the radius of which tends to zero with the radius of the aerial wire, but more slowly. These points, and others that follow from the same line of argument, are not made in the present book. For this reason it may be doubted whether the book gives a good lead for the future of aerial theory, although it undoubtedly describes the past quite well.

For the future of electromagnetic theory in general there are two respects, however, in which the book does give a good lead. Although the author makes no serious use of field impedance, he not only uses circuit impedance but also gives, early in the book, a better description of what is involved in the concept of reactance than seems to have appeared in any previous book on the theory of the electromagnetic field. In addition, all equations have been written in rationalized universal units (in particular rationalized metre-kilogram-second-coulomb units), thereby facilitating physical and engineering interpretation. Both these features symbolize the complete unification which has been taking place during the past decade, and is still going on, between the theory of electrical circuits (dealing largely with interchange of stored electromagnetic energy) and the theory of electromagnetic waves (dealing largely with propagation of electromagnetic energy and developed in the first instance particularly for optics). It is a pleasure to see that post-war books on this subject from the Clarendon Press are displaying the new spirit in electromagnetic theory.

To sum up, it may be said that, as a connected account of classical contributions to fundamental aerial theory, the book is well worth reading and well worth keeping to hand. H. G. BOOKER

BRITISH BUTTERFLIES

Butterfly Lives

By S. Beaufoy. Pp. 128. (London: Wm. Collins, Sons and Co., Ltd., 1947.) 12*s.* 6*d.* net.

THIS book of nearly two hundred pictures will give pleasure to many who are interested in animal photography.

Mr. Beaufoy has illustrated, in all stages, twenty-two of the sixty-eight British butterflies, representing every indigenous family, though the distribution of the species selected is rather uneven. Thus there are seven Nymphalidæ, five Pieridæ, five Lycænidæ, but only two Satyridæ: the others are the 'Duke of Burgundy', a 'Skipper', and, of course, the 'Swallow Tail'. We feel that it would have been a more notable feat to show more of the Satyridæ with which the public is less familiar, and omit some of the well-tried favourites.

Dr. Ford points out in his preface that the species are selected to show the characteristics of every indigenous family, and these are indeed brought out. We particularly appreciate the photographs of eggs, of which the shape and sculpture proper to each are beautifully shown. The figures of very young larvæ are a welcome novelty. Most people are familiar with a series of pictures of a butterfly emerging from the chrysalis: less often studied is the remarkable escape of the freshly formed pupa from the hampering larval skin, as shown in a series of six pictures of the small Tortoiseshell at this crisis in its life-history. This seemed to me one of the most instructive series in the book.

Lycænid pupæ are less successfully figured: perhaps a little less magnification would have been better suited to their rather shapeless obesity. On the other hand, the picture of the pupa of the 'Duke of Burgundy' is particularly revealing. The fragrant osmeterium of the larva of the 'Swallow Tail' is well shown.

The letterpress adequately discusses the illustrations, with a few notes on habits, etc.: but the book is, primarily, a picture book. The photographs are certainly "from life", but so is a photograph of a tiger in a cage, and the phrase must not be taken always in its fullest implication. Mr. Beaufoy freely admits that, in photographing butterflies, "really good results, out of doors, are rare", and tells us how, with artificial lighting, he provides "a suitable" setting of foliage or flowers. However, as Mr. Beaufoy's object was "to depict the detailed characteristics of the different species" the question whether, for example, the beautiful picture of the variety of the 'White Admiral' on bramble blossom was taken within or without the studio need not worry us unduly. There can be little doubt about the 'Swallow Tail' feeding from *Buddleia*! Two errors "Aphantophus" (p. 10) and "Lycænidine" (p. 79) should be corrected. G. D. HALE CARPENTER

FIREPROOFING OF FABRICS

The Fireproofing of Fabrics

By J. E. Ramsbottom. Pp. vi+121+11 plates. (Department of Scientific and Industrial Research; H.M. Stationery Office, 1947.) 2*s.* 6*d.* net.

ONE of the major defects of most textile fabrics is their inflammability, and as early as 1638 attention was directed to the use of clay and plaster-of-Paris to reduce the fire risk of canvas used in theatres, while in more recent times the need for fireproofing is periodically emphasized by the comments of coroners on the inflammability of children's flannelette garments. Fireproofing is also of considerable importance to the Services, and in 1930 a preliminary account of investigations carried out at the Royal Aircraft Establishment at Farnborough was given in the second report of the Fabrics Co-ordinating Research Committee.

The present publication is a description of further studies by Dr. Ramsbottom and his colleagues on the subject of fireproofing, together with a new presentation of some of the information given in the earlier report. The object of the investigation was two-fold—to examine the effectiveness of the various fireproofing processes described in the technical and patent literature, and to develop a theory of fireproofing. A treatment which is to be successful commercially should have no adverse effect on the material, and this aspect must be taken into account when assessing the relative merits of various methods. The proofing of kapok, for example—a problem which has been considered in some detail—must not affect the buoyancy of this material. Work of this type has necessitated the development of new methods of experimentation, and the description of these constitutes a valuable guide for other investigators.

The theoretical aspects of fireproofing were first studied by Gay Lussac in 1820, but until recently it was not possible to account for the differences in effectiveness of closely related compounds. As a result of Dr. Ramsbottom's work, however, it may be concluded that fireproofing agents are in general effective because they act as catalysts which modify the changes accompanying the thermal decomposition of cellulose. This hypothesis, which is elaborated in detail for both soluble and insoluble fireproofing agents, will serve as a useful basis for further investigations.

Dr. Ramsbottom's monograph is not a text-book of the usual type—it is primarily an account of his own experimental work—and is written clearly with the detail associated with original contributions. It is authoritative except when dealing with the relative inflammability of various textile materials. This section could with advantage be modified; certainly the term 'artificial silk' should not be used, and some indication should be given of the different fire risks associated with the many types of modern rayons.

Although the booklet does not deal with all aspects of fireproofing, it is an important contribution to the subject and should become a standard work.

A particularly useful feature is a comprehensive list of fireproofing reagents, and the suggestions of the authors as to suitable methods of fireproofing will be of great assistance to practical men called upon to produce fireproof goods. C. S. WHEWELL

Invertase

A Monograph. (Scientific Report Series, No. 4.) By Prof. Carl Neuberg and Dr. Irene S. Roberts. Pp. ix + 62. (New York, 5: Sugar Research Foundation, Inc., 52 Wall Street, 1946.)

THIS useful monograph on invertase by Prof. C. Neuberg and his daughter, Dr. I. S. Roberts, is a Scientific Report of the Sugar Research Foundation, Inc., of New York. As might be expected from so eminent an investigator as Prof. Neuberg, the monograph gives a succinct and authoritative account of the properties, sources, and modes of preparation of one of the earliest known enzymes. The methods of purification of invertase by adsorption techniques, first used with success by Willstätter, and by precipitation procedures are described in some detail.

Invertase was discovered more than a hundred years ago, and while its study has played an important part in the development of our knowledge of enzymology, its industrial importance, especially in the sugar industry, has not been perhaps so well recognized. Invertase was employed extensively in the preparation of molasses for the supply of sugars to alcohol plants during the times of great urgency when alcohol was required for making synthetic rubber. It plays an important part in the manufacture of confectionery. Biochemists will do well to read this monograph, which summarizes recent literature (405 references) on the subject.

It is unfortunate that the monograph is not entirely free from error. Thus the statement that Quastel and Yates have reported on the inactivating non-reversible influence of both basic and acid dyes is incorrect. These authors (*Enzymologia*, 1, 60; 1936), on the contrary, have shown that both basic and acid dyes combine reversibly with invertase according to mass action laws. In fact, the equilibrium between invertase and acid and basic dyes provides an excellent example of the reversible combination between the ions of an enzyme and those of organic inhibitors such as the dyes. The equilibrium constants of the enzyme–dye combinations were determined, and these results, together with other facts, led Quastel and Yates to the suggestion that invertase acts as a *zwitterion*, the oppositely charged groups of which may be bridged by sucrose when this is present as substrate.

The Soochow Astronomical Chart

By W. Carl Rufus and Hsing Chih Tien. Pp. v+24+2 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1945.) 14*s.* net.

THIS chart and the text appearing with it constitute instructions for an Emperor and were prepared in A.D. 1193 and engraved in stone in 1247. More than thirty years before they were engraved the capital had been moved from Peking to Kai-Feng Fu, in Honan, but in 1267 Peking was restored as the capital. We are informed in the text that before the Great Absolute had unfolded itself the three primal essences, heaven, earth, and man, were involved within it. The Great Absolute evolves into the sun and the moon, divides into the five planets, arranges in order as the twenty-eight mansions, and meets to form the directors (the Plough) and the circumpolar stars. In the description of the sky the equator is called the Red Road, the ecliptic the Yellow Road, the moon's path the White Road, and the Milky Way the River of Heaven. The planets are the essences of the five elements—wood, fire, earth, metal and water—these elements constituting the planets Jupiter, Mars, Saturn, Venus, and Mercury, respectively. A description of the star map, the purpose of which is astrological rather than astronomical, is given on pp. 8–10. The asterisms follow the traditional oriental pattern—terrestrial beings personified, especially the Emperor, his court, and numerous officials, which differ from the predominant mythical heroes of the West, including supernatural or superhuman personages.

The authors must have spent much time and energy on the production of this work, which will interest all who study the history of ancient constellations.

The Mentally Ill in America

A History of their Care and Treatment from Colonial Times. By Albert Deutsch. Pp. xvii+530+8 plates. (New York: Columbia University Press; London: Oxford University Press, 1946.) 26*s.* 6*d.* net.

"THE Mentally Ill in America" outlines the history from the earliest times of the attitude towards the insane of their fellow men, particularly in the United States. The author has spent a great deal of time on literary research, and the result has well repaid the time spent. Benjamin Rush, Dorotha Dix and Clifford Beers, names very familiar to English-speaking psychiatrists and others concerned in the care and treatment of the mentally sick, come in for prominent mention, as well they deserve. The detail given is extraordinary and makes a fascinating study; but the author presents mental hygiene with a stupendous task when he posits the goal toward which mental hygiene must strive as "a world of peace and freedom, from which the twin specters of war and insecurity will be banished, a world of equal opportunity, where people will be freed from stunting inhibitions and guilt feelings arising from outworn prejudices and taboos. . . ." What an objective, and how hopeless it seems in the present state of society the world over! G. W. T. H. FLEMING

A New Arithmetic

By A. W. Siddons, K. S. Snell and E. H. Lockwood. Part 1. Pp. vii + 184. 2*s.* 9*d.* Part 2, including Numerical Trigonometry. Pp. viii + 210. 3*s.* Part 3, including Numerical Trigonometry. Pp. vii + 151. 2*s.* 9*d.* Notes and Answers for A New Arithmetic. Pp. ii + 90. 5*s.* (Cambridge: At the University Press, 1947.)

THIS new arithmetic consists of three parts, published separately. Part 1 revises the elementary processes of arithmetic, including mensuration, and includes a chapter on statistical graphs. Part 2 begins with the use of four-figure tables of squares, square roots, reciprocals and logarithms. Through the elements of mensuration it leads to numerical trigonometry. Part 3 is devoted to further work on trigonometry, mensuration, more difficult percentages, compound interest, civic arithmetic, stocks and shares, followed by an introduction to statistics for post-school certificate reading.

Carefully graded sets of examples are provided, together with many revision papers. A commendable feature is the emphasis laid upon the proper use of English in writing out the solutions.

Teachers' editions are published separately for Parts 1 and 2 giving notes and answers; the latter are not provided in Parts 1 and 2, but are given in Part 3.

SCIENCE IN WAR AND PEACE*

By Sir HENRY DALE, O.M., G.B.E., F.R.S.

THE officers and Council of the British Association have naturally wished that this meeting should take special note of the emergence of science, in Britain as in other countries, from its abnormal concern with war, and its return to the service of peace. To rally and to give direction to the thoughts of the members and of the sectional officers in this general sense, the phrase 'Swords into Ploughshares' was suggested, and adopted by the Council, as a motto for the meeting. Even in its most obvious meaning, of the direct adaptation to peaceful uses of the practical results of researches made to meet the demands of war, or forced into rapid fruition by the heat of its urgency, the metaphor will find abundant application in this week of discussions. Let me choose a few, almost at random, for mention now.

How many decades of research do you suppose, undertaken in response to no stimulus stronger than the desire to add to the resources of peace, would have been acquired for those developments of radar, which were achieved in a few years under the imminent threat and the realized peril of war ? It is certain that the scientific activities of peace had never witnessed anything like the intimate collaboration of British and American physicists and engineers, which finally played so important a part in giving full effect to this triumph of science in the service of war.

Aeronautical science, having received a great stimulus in the First World War, and having undergone a steady development in the intervening years, sprang again into a phase of headlong progress under the threat and the experience of the Second World War. Now we wait to see what will be the effects, on speed and safety in peaceful transport, of gas-turbine engines and jet propulsion, of stratosphere flight in pressure cabins, and of the fundamental changes in aircraft design, which are all still under rapid development.

Sir Alexander Fleming had encountered the first evidence for the existence of penicillin and described the general nature of its action in 1929, ten years before the War began ; but, during that interval, its interest had remained little more than that of an item in the natural history of moulds and bacteria. Sulphanilamide and its derivatives, meanwhile, had opened a new vista of chemotherapy for the bacterial infections, and gramicidin had provided an example of a natural antiseptic, an 'antibiotic' of practical potentialities ; but exploration, in this field also, was to wait for war's demands to give it a full and urgent acceleration. And we cannot doubt that the wider survey by Sir Howard Florey and his team, which led them, in 1939, to take penicillin down from the shelf of sound but unexploited observation, for the new study which brought it so rapidly into practical use, owed some of its stimulus to the gathering menace of war. We may certainly assume that the lavish character of the industrial research and enterprise, which then so quickly overcame the difficulties of manufacturing penicillin on a large scale, was chiefly due to recognition of the part which it would play in the conduct of the War. This industrial production, again, made penicillin, and then several penicillins, more rapidly available for the purely scientific investigation of their structures. Here, again, the conditions of peace have never produced such a remarkable co-operative effort of research as that in which teams of some of the leading chemists of Britain and of the United States pooled their results, solved the difficult structural problem with what, by normal standards, would have been an astonishing rapidity, and even, in the case of one of the penicillins, confirmed by synthesis the structure to which the less-direct evidence had pointed.

French, British and Italian investigations had all contributed to the discoveries which had identified the blood parasites causing the malarial fevers, and revealed the manner of their transmission by mosquitoes, all before the present century began. Little more than detailed advance, on the other hand, had been made in the curative or preventive treatment of malaria by medicines since the seventeenth century. Cinchona and its chief alkaloid, quinine, had continued to provide the standard medicinal treatment, although, between the Wars, the research enterprise of German industry had produced two new artificial remedies. One of these, indeed, known as atebrine, and later in Britain as mepacrine, was understood to be comparable in action to quinine, though there had been no sufficient inducement to its extensive trial as a substitute. It was fortunate, then, that, as a military precaution, the effective manufacture of mepacrine had been undertaken in Britain, and then in the United States, before Japan seized, in the East Indies, the source of most of the world's supply of quinine. Under the continued stimulus of war's demand, again, a new campaign of chemotherapeutic research was opened in both Britain and the United States, to seek yet better remedies than quinine or mepacrine. Again there was a co-operative exchange of information and materials between the workers in both countries, and the investigation was conducted on such a scale and with such organisation of effort as had never been contemplated in peace. In a surprisingly short time came reports of new lines of development showing great promise ; and a British one of these has culminated, so far, in the discovery of paludrine, a synthetic antimalarial substance of a new type, more effective, and at the same time much freer from harmful accessory activity than quinine, or mepacrine, or any other of its predecessors.

The needs of war, again, soon presented to engineering, on one hand, and to physiology and experimental psychology on the other, a group of practical problems arising from the unnatural conditions of physical and mental stress to which men were exposed in the constantly developing machines of modern warfare, as well as from the extremes of climate and the deprivations to which they were subjected by military necessity or accident. The researches which were framed and conducted, in response to these varying demands, have produced a great volume of new knowledge concerning a variety of conditions which favour or hinder the different activities of man's body and mind, and their resistance to the influence of fatigue.

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*Substance of the Presidential Address to the British Association for the Advancement of Science delivered at Dundee on August 27.

Not all the uses of war-time discoveries in peace will depend on applications so direct and obvious. There are examples already, and it is most likely that more will appear, of inventions made with no purposes but those of war, which have found peaceful use in directions entirely unforeseen. For example, an artificial chemical substance, di-isopropylfluorophosphonate, now commonly known as D.F.P., was first made and studied in Britain, as an active member of a poisonous series, known to be under trial in Germany as potential weapons of chemical warfare. The actions of D.F.P., some of them unpleasant enough, were found by workers in Britain, whose results were later confirmed by colleagues in the United States, to be due to its power of annulling the action of cholinesterase—an enzyme widely distributed in the animal body, and playing an important part in relation to the transmission of a number of nervous effects. D.F.P. was never used, in fact, as a chemical weapon ; but the action which might have led to such employment has already made it, not only a most interesting and valuable tool of physiological research, but also, according to recent news from the United States, an invaluable remedy, when suitably administered, for the dangerous paralysis of the intestine which may follow an operation. So the wheel has come full circle, and the sword, forged as a lethal weapon, finds use, not only as a ploughshare of peaceful research, but even as a shield for threatened lives.

The sectional meetings during the week will certainly have under discussion many more of such direct applications and extensions of discoveries and inventions made in war to the ordinary needs and purposes of peace. These will constitute, however, only a part, and very likely not the most important part, of the incidental and compensating gains of science itself, and of mankind through science, from this participation in the researches required by war. Scientific research may expect to obtain, from inventions thus made for special and quite unrelated purposes, new tools and facilities for the general advancement of natural knowledge over wide ranges. The development of rockets as weapons of extreme range, for example, may provide means for obtaining data of physical conditions, at altitudes from the earth's surface previously far beyond the reach of scientific exploration ; and the great advances made in aerial photography will certainly find application for purely scientific surveys of various kinds, over land and sea. And, apart from many and great additions of this kind to the physical and technical resources available to research, there will be lessons to be learned from war's experience of the methods of planning and organising research, of the recruitment of special research teams, of the value, for the rapid attainment of a particular objective, of co-operation on a national and, as in cases which I have quoted, on an international scale.

Scientific method has had new opportunities of demonstrating its value in the range of the so-called 'operational' researches, in which, for the first time in any war, a largely successful effort was made to collect, and to subject to scientific analysis, accurate data of the performance of new weapons, and of the outcome of new methods. All such experiences in war will have left lessons which may have value in peace, to science in the pursuit of its normal objectives, and to the world at large in a new understanding of what science can be expected to do, and of the kind of aid it can offer towards the solution of suitable problems.

While we may well be eager, however, to ensure that science and those who cultivate it should thus retain and exploit the lessons of value which they learned in their service of war, it may be of at least equal importance that they should, with all rapidity and thoroughness, forget others which ought to be discarded. It is scarcely to be doubted that, to many men of science, the War brought opportunities for research under conditions which made it, in various ways, and in spite of the strain and anxiety of the time, more immediately attractive than any that they had previously encountered. Comradeship, effective even across some national boundaries, in work for a great cause, without thought of personal credit or recognition ; an escape, perhaps, from indecision concerning the scientific worth or soundness of a line of personally chosen research, and from anxiety as to material resources for its pursuit, into a world of authority and planning, of problems posed by actual emergencies, of practical issues and tangible results, and of facilities without restriction ; and a sense withal of high duty performed for the future of his country and of the world, by the use of a man's own special knowledge and skill, and not always without danger—duty as clear and unquestionable as others could only discharge by a sacrifice of all their normal instincts and interests and, for many, of life itself—all these conditions of scientific war service may have given to many a man a different kind of satisfaction from any which had come to him from the normal experience of a man of science in peace.

I suggest that there may be danger to science from a tendency to transfer too easily and completely, to the activities of peace, the attitude to research and the traditions of its conduct which have been acquired during six years of such war experience.

I am not, of course, speaking just now of the perversion of science which war research involves through its particular concern with the means of slaughter and destruction. For the moment I am concerned with the fact that the response to war's demands has led the majority of scientific workers of Great Britain to devote nearly the whole of their thoughts and efforts, during six years or more, to practical problems presented to them for rapid solution. There must, indeed, be many younger men who have had little experience of other kinds of research than that which has been thus directed and restricted to near and practical objectives, and carried out under a pressure of urgency. From Government organisations and industry, awakened by war's experience to a fuller awareness of what science can do for them under such conditions, it is not likely that encouragement will be lacking for a continuation of similar activities into peace. I myself, indeed, have been bringing to your notice the claims of lines of research which had proved fruitful of practical result for the purposes of war, to be continued and developed now, with a new orientation, to serve those proper to peace. I must make it clear, then, that it is far from my intention to suggest a predominance, in the programmes now to be shaped for science, of such transference to peaceful uses of the research enterprises of war and the methods by which they have been conducted.

Does anyone doubt that, to enable science to render its best service to mankind, we need now to take a long-range view and to give our first care to the extension of fundamental knowledge, unconstrained by aim at any practical objective ? I am not here concerned to advocate, or to defend, either of the rival philosophies, postulating the advancement of pure knowledge on one hand, or the material betterment of man's lot in the world on the other, as the ultimate true motive of the scientific effort. I believe that it would be admitted, by partisans of either, that research which seeks only to advance pure knowledge commonly leads, in the end, to the widest practical developments; and examples are to be found of the contrary, when practical researches are conducted under conditions which leave full freedom to follow fundamental issues, as these present themselves. The concentration, however, of practically the whole of a rapidly growing scientific effort on practical applications and developments, such as the War has witnessed, might find instructive analogy in a rapid and even reckless extension by a commercial undertaking of its trading enterprise, without care to conserve and proportionately to expand its resources of working capital. In theory I think that this is generally recognized, and I am not assuming that any of the different authorities which now provide material support for science in peace will hesitate to give generous encouragement to fundamental researches. My fear is rather that we men of science may find it difficult to shake off quickly the spendthrift habit in research, the policy of trading for quick returns, which six years of war experience may so easily have fostered.

There are other directions in which, I suggest, we should be alert and watchful against too ready an acceptance of lessons learned in war research as applicable directly to the needs of science now. The world never possesses at any time too many men of the highest kind of qualification for research in science—men who, by their own personal effort and achievement, can exert a determinant influence on the rate and the direction of the advance of knowledge into the unknown, and can open new fields of science to detailed exploration by others. There may be men of that type who found that, in the years of war, they could give their best service to science, as well as to the nation and to the cause for which it stood and fought, by organising and planning researches for teams of men with narrower experience and outlook, and by bringing scientific methods to bear on problems of military policy. I believe that scientific services of that kind, rendered in war, have earned far more than they will ever receive in the way of acknowledgment; but I venture to voice a hope that men with the rare, creative ability that science needs now for the resumption of its normal progress, whose influence and example are needed in the schools for the inspiration of those who will follow, will not too readily assume, or too easily be persuaded, that their best service to science will still be rendered by planning and organising, or by bringing scientific ideas to bear upon policy. Here, again, I believe that, under conditions now to be faced, the building up of our scientific capital of fundamental knowledge by those who have the creative gift should have a prior claim over its practical exploitation and the cultivation of its political influence.

There are many, I think, who will be remembering with me the mood which prevailed among men of science when the First World War ended in 1918; how we looked forward then with eager hope and confidence, ready to write off the losses and delays which those four years of war might have inflicted on science, and determined to conserve for it all that could be counted as gain. The role of science in that War had, indeed, been relatively small. For the general body of men of science it had begun on a basis of opportunist intervention or response to special appeal, to deal with emergencies as these arose, the country's scientific reserves being called upon tardily and never completely enrolled. And, when victory came in 1918, the men of science, with few exceptions, were able quickly to escape from war's abnormal duties and commitments, and to return rejoicing to the free air and the wide horizons of science, as they had known it earlier in peace. Lessons had been learned then, as now; the Government and public opinion had gained a new conception of the support of scientific research as a national investment; but thoughts of war, and of its claims on science, receded rapidly then into the background. And although what was to have been a permanent peace proved, in the event, to be less than two decades of an uneasy armistice, with the shadow of another war then rapidly encroaching, what a wonderful new flowering of science was witnessed in that short interval!

Think of the speed and completeness with which our ideas of the universe of matter, of atoms and of the ultimate, subatomic particles, of elements and their mutability, were then being recast; of the transformation, as rapid and impressive, of conceptions of the life process and its physico-chemical background by the advances then being made in organic and physical chemistry, with biochemistry in ever more intimate alliance with them; of the new worlds of knowledge and ideas which were then being opened by the linking of genetics and nuclear cytology, giving a physical basis to the complexities of heredity; or of the first systematic study of the properties of ultramicroscopic viruses, linking, in a manner still mysterious, the characters of matter in macromolecular solution with those of the smallest living and self-propagating organisms. From all these, and from fundamental advances of comparable rapidity and significance in almost all fields of scientific activity, rich harvests of new development and extension were continuously being reaped, by medicine, agriculture, industry, and all branches of applied science. Never, surely, in all previous history, had science surged forward with such impetus as in that interval of years when, in spite of recurrent economic and international crises, a lasting peace seemed still not beyond hope, and a golden age, for a world entering the scientific era of its history, a not impossible aspiration. And, for science itself, one of the points of brightest hope and encouragement was to be found in the steady rebuilding in that interval, in spite of initial obstacles and discouragements, of a true world community of science.

We know how tragically that interval of optimism and of free progress in science, so rapid and so various, came to an end. We cannot expect or even encourage a quick revival of that earlier mood. We are faced now by the contrast between the parts played by science in the two World Wars. In that from which we recently emerged, science, no longer a mere accessory, has moved right into the centre of the picture; and by a process of which we may, perhaps, find the tentative beginning in 1915, with the first use of chemical warfare as a weapon of mass slaughter and disablement, the belligerent use of science has undergone a rapid transformation, turning it into a weapon and a combatant in itself, released from afar for the undiscriminating infliction of death and destruction, at rapidly growing ranges and on an ever increasing scale. The atomic bombs on Hiroshima and Nagasaki represent, of course, the proximate peak of this development, so far as it has yet been made known; but nobody can suppose them to be the climax of disastrous achievement, if the nations should persist in the desperate project of using further advances in this, or in any other department of science, to prepare in secret, each to excel or to anticipate others in perfecting the means of annihilation. Does the world need yet to be warned as to the end of such a policy? If so, we men of science must continue, against any reluctance to repeat and to insist, to proclaim the danger, and our hatred of the perversion of science to its creation.

Meanwhile we have our own problem of the effect of such a position on the prospect of science itself. For a devotion so complete to the service of war as that which was given in recent years has involved many men of science during its progress in obligations of secrecy entirely new to their experience; and there are important sections of scientific activity which have not yet been able to escape from these trammels. That concerned with the release of atomic energy, with all the side-issues into new lines of scientific progress which that gigantic war enterprise might have made, and will yet, we hope, make available, provides the most conspicuous case. This might, indeed, be regarded as epitomizing, or presenting, by way of an extreme example, the way in which science in peace may inherit opportunities from developments for which war alone could have set the scale and provided the momentum, and the threat to the freedom of science which may be entailed by the same inheritance. Though the scientific basis for its prediction was available in 1939, before the new War broke out, nothing but war, and the need to anticipate a danger of such magnitude in war, could have brought about an effort on the scale needed to convert the release of atomic energy by a chain-reaction from theory to practical reality in a few years. If peace had remained unbroken, the world might have had to wait for many decades to reach a point of such possibilities, for new departures and rapid advances in a whole range of fundamental sciences. War immensely accelerated the presentation of this opportunity to science; but, in doing so, compromised the peaceful use of it by the hideous threat of its further abuse in war. Science, then, finds itself facing a situation in which hope and frustration contend; the need to make the world safe, and the delay of agreement on the means of doing so, clog wheels of science which should now be turning freely for the enlightenment of mankind and the enrichment of human life, many years, perhaps many decades, before they could have done so if the War had not yet come.

How then are we men of science to deal with such a situation? With unquestioning loyalty to all our obligations—that first and foremost; but then also, I would urge, with a resolute watchfulness against any encroachment, on activities proper to peace, of a secrecy which we accepted as an abnormal condition in war, and with a determined effort to accelerate the liberation of science from its entanglement. In the universities in particular I hope that we shall be able to ensure that the men of science of the near future will grow up, as we their predecessors did, in an atmosphere of scientific freedom, and be ready to accept, in their turn, the duty of standing, at need, in the defence of science in its full integrity. And I hope that we can keep as the constant aim of our endeavour, in spite of all that might excuse discouragement, the revival of an intimate brotherhood of the men of science of all nations, working together in full confidence, once more as a world community.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

EARTH, STARS AND RADIO

During the year 1947 we are celebrating in Great Britain two important jubilees, one technological and the other scientific. It was in 1897, fifty years ago, that Marconi, the young Italian inventor, gave a decisive demonstration of 'telegraphy without wires' to Sir William Preece, who was then engineer-in-chief of the British Post Office. It was also in 1897 that the Cambridge professor of experimental physics, Prof. J. J. Thomson, made the first public announcement, at an evening discourse at the Royal Institution, of the existence of the electron as an independent entity. The technological development of radio from those early beginnings has had most important scientific consequences. Correspondingly, the scientific discovery of the electron, although important in the first instance because of its bearing on atomic theory, has had profound technological consequences. Indeed, it is scarcely possible to cite better examples of the mutual influence of fundamental science and technology than the developments which have sprung from those two great events of fifty years ago. These developments form the subject of the presidential address by Sir Edward Appleton to Section A (Physical Sciences).

The progress of radio as an agency for exploring the universe has followed directly from two electronic developments, namely, the thermionic valve and the cathode ray oscillograph. With the thermionic valve it is possible to generate radio waves of almost any wave-length. Moreover, such waves, if sufficiently short, can be emitted or received in any desired direction. It is also possible to arrange that their emission takes place in spurts, or pulses, which can be detected again if the waves are reflected by any natural agency in space. The cathode-ray oscillograph can, on the other hand, be used for the measurement of short radio echo-delay times, and also for the delineation of the wave-form of naturally occurring radio transients.

Using such radio and electronic techniques, the wave-forms of atmospherics, originating in lightning flashes, have been studied in some detail, and instantaneous methods have been developed for finding thunderstorm positions at a distance. Similarly, the use of centimetric wave radar echoes has led to methods of estimating the extent of rainfall areas.

During the War it was discovered that coastal radar stations sometimes received echoes from a ship which had passed well beyond the horizon. The detailed examination of this connexion between radio and the weather has led to the discovery that the lowest layers of the atmosphere may sometimes bend radio wave tracks with a curvature exceeding that of the earth. Such abnormal refraction is associated with temperature inversions and marked water-vapour lapse-rates.

The use of radio-wave exploration for investigating the electrical state of the upper atmosphere has been the subject of continuous experiment in Britain since 1925. It has been found that the ionosphere is subject to a marked solar control, there being a general waxing and waning of the ionization densities in sympathy with the trend of the sunspot cycle. Transient radio echoes have also been noted from the levels of the lower ionosphere, and these have been traced to reflexions from meteor trails.

Finally, the use of sensitive short-wave receivers has disclosed the terrestrial reception of radio noise from both the sun and the stars. Sunspots are found to be powerful emitters of 5-metre waves, the emission being specially enhanced at times of visual solar flares. A continuous radio noise has also been identified as originating in the Milky Way. It is not yet known whether such galactic radio noise originates in interstellar space or in sunspot regions on the stars themselves.

SCIENCE IN THE COLONIES

AFTER reviewing some of the historical examples of the application of research to Colonial problems, Dr. J. L. Simonsen, president of Section B (Chemistry), emphasizes that only with the help of men of science could many of these be solved. While agriculture must continue to be a main industry of the Colonies, its maximum development will require research of a high order. The Colonies can, however, no longer be regarded solely as prime producers, and the introduction of other industries deriving their raw materials from agriculture will be essential. In 1942 the Colonial Products Research Council was formed to review the field of Colonial raw materials, and by research methods ascertain how fuller use could be made of them.

Large-scale industry based on plant products must look to the most abundant of these, namely, the carbohydrates, starch and sugar, as its raw materials. Starch already finds an extended application in industry, and the methods devised at Birmingham for the separation of its two constituents, amylose and amylopectin, have now rendered these products readily accessible. A detailed survey of the little-known starches of tropical Colonial countries is urgently needed. Although sucrose is the organic chemical produced on the largest scale, it has been little used as an industrial raw material apart from fermentation processes. The sucrose molecule is complex, and rapid progress of research into the production of substances of increased industrial value which is now being carried out in Great Britain and the United States cannot be expected, although some of these have been shown to have useful antifreeze, plastic and chemotherapeutic properties.

Recognition of the importance of microbiology has resulted in the decision of the Colonial Products Research Council to open a Microbiological Research Institute in Trinidad. Among the problems it is hoped to attack are those associated with soil fertility and the control of the Panama disease of bananas.

Synthetic organic chemistry has replaced many drugs previously obtained from plants; but this does not, however, diminish the need for a study by modern technique of the constituents of plants with which medicinal properties have been associated. Furthermore, it has been shown that the botanist can no longer disregard the nature of the chemical constituents in his classification of plants.

The value of improved methods of agriculture and the control of soil erosion will be neutralized if steps are not taken to prevent the large losses of the world's food supply incurred through pest infestation. If the new synthetic insecticides, D.D.T. and 'Gammexane', can be shown to be used with safety on foodstuffs, a weapon will be available which should largely eliminate this destruction by insect attack.

Of even greater importance is the control of two of the foremost insect enemies of man and animals, the mosquito and the tsetse fly. Experience with the new insecticide sprays against the mosquito indicates that the problem is not insoluble, and if by a co-ordinated attack on malaria in conjunction with the use of prophylactics, such as paludrine, meets with success, science will have made an outstanding contribution to Colonial prosperity. The control of tsetse, the transmitter of trypanosomiasis, presents a problem of far greater difficulty. The fly can be killed if brought into contact with insecticides, but it is not yet known how best this can be done. Possibly the use of smoke or smoke bombs from aircraft may be a solution; but the problem must be vigorously attacked on a scale commensurate with its magnitude.

GEOLOGY IN THE DEVELOPMENT OF THE COALFIELDS

IN conformity with the general theme of 'swords into ploughshares', the presidential address to Section C (Geology) by Dr. Murray Macgregor deals with the place of geology in the development of the coalfields. The transference of the coal mines of Britain from private to public ownership has created an entirely new set of conditions, bringing with them their own complexities and hazards and demanding vigilant and unsparing service from all concerned. The unified industry will certainly require the best scientific and technical assistance that the country can give. Scientific research applied to the numerous problems that arise in connexion with the exploitation and utilization of the coal resources of Great Britain must be more directive and more closely integrated than in the past. There are the problems connected with occurrence, distribution, structure and correlation; with vertical and lateral variations in the number and thickness of seams, in the lithology, and in the fossil content; with the size and direction of faults, the amplitude and pitch of folds, the occurrence of suites of contemporaneous igneous rocks and of intrusions, etc. There are the chemical and physico-chemical problems connected with the composition and classification of the coals, and the problems related to their preparation for the market and their economic use.

The fact that the geologist is the first link in this chain of concerted effort is too often overlooked or forgotten, and it must be emphasized that all development schemes, short-term and long-term alike, depend upon a proper and thorough knowledge and appreciation of the relevant geological conditions. In the new era opening out, the unified coal industry, with all its potentialities and its capacity to quicken or retard the *tempo* of our whole national life, must receive all the assistance that geology can provide in planning ahead, in suggestions for economic working, in interpreting structures, in reading doubtful sequences, etc.

The task of the geologist in the coalfields is to correlate and assess all the information already available, to advise as to future developments, and to follow these up much more closely than it has been possible to do in the past. This cannot be achieved by periodic efforts or by a discontinuous service. Research in the coalfields is not a series of separate *ad hoc* pieces of investigation but a continuous service which requires a full-time staff. It is only in this way that geology can be enabled to take its proper place in the economic life of the country. It is only in this way, too, that the gaps in our knowledge of many aspects of Carboniferous geology can be filled, and a more and more broadly based synthesis built up. The coal-mining industry has now become a national trust, and it is as such that it must be regarded by all; the issues are clear-cut and indeed vital, and it is for geologists to see that geology plays its part in the difficult times ahead.

ZOOLOGISTS IN WAR AND PEACE

DR. EDWARD HINDLE, in the opening remarks of his presidential address to Section D (Zoology), mentioned that in view of the exceptional conditions under which they met, he proposed to devote his address to an account of some of the work in which zoologists had been engaged during the past few years. He first referred to war-time activities and gave a brief account of the application of the principles of animal coloration, known as camouflage, and also of some work on anti-fouling. Special attention was devoted to the contributions of zoologists to the maintenance of our food supplies, without which it is very doubtful whether the country could have been adequately fed. An important section of this work was the protection of our food stocks against animal pests, and mention was made of the work of the Bureau of Animal Population at Oxford on rodent control and the development of the Infestation Division of the Ministry of Food. The activities of the latter were dealt with at some length, since it developed as a direct result of war conditions and was staffed mainly by graduates in zoology.

Various attempts were made during the War to increase food supplies. These included extending the use of unmarketable fish which, in the English Channel alone, resulted in the production of about 1½ tons a week of excellent fish-paste from fish that was formerly wasted. The experiments at Loch Sween (Argyll) on the possibility of raising the fertility of a given area of the sea by the addition of nitrates and phosphates were also considered.

Zoologists took a prominent part in some branches of operational research. In particular, they were closely involved in the practical development of radar in connexion with gun-laying devices for anti-aircraft guns, and the development of 'H_2S', an apparatus used for the localization of targets. Eventually this was fitted in various aircraft, and its use resulted in enemy submarines being brought under control during the first half of 1943. Moreover, they did not become a serious menace again until the invention of the 'Schnorkel' in 1945.

Zoologists were found to be particularly well-fitted to cope with the early difficulties of radar, since by their training they become accustomed to handling large numbers of uncontrollable variables.

Some of the peace-time activities of zoologists were then referred to, with special emphasis on the work of entomologists in checking the serious losses in our agricultural products, stored products, and in the prevention of disease. To take only one item, the loss of grain in India, due to rodents, insects and moulds, has been estimated to amount to 12–15 per cent, and a saving of 10 per cent would be sufficient to prevent a famine. In Africa the Colonial Development Scheme, involving the expenditure of some £24,000,000 in the production of ground-nuts, would mean the use of mechanized agriculture on an unprecedented scale in that continent, and would create conditions favourable to the spread of animal pests and disease. Dr. Hindle expressed the hope that the number of professional biologists employed in this project would be commensurate with this expenditure.

The subject of taxonomy was then discussed, and the increasing difficulty of getting accurate identifications of species. An Empire Biological Service, somewhat analogous to the Fish and Wild Life Service in the United States, was suggested, as this might offer the possibility of establishing a pool of taxonomic specialists who could be attached not only to national and provincial museums in Britain, but also to corresponding institutions in the British Empire. Ultimately, this might be extended on an international basis. Finally, Dr. Hindle stressed the educational value of an academic training in zoology, which was out of all proportion to its economic possibilities; and appealed for a return to a less mechanistic training of the younger generation.

GEOGRAPHY IN WAR AND PEACE

IN her presidential address to Section E (Geography), Prof. E. G. R. Taylor points out that, while everyone admits that 'circumstances of place', that is, geography, are relevant to human history and human affairs, it remains true that geographical circumstances are normally regarded as 'accidents'; and as being, moreover, of so obvious a character that it needs no trained geographer to point them out, much less being such as to deserve analysis in detail. This over-simplified idea of geography, which can be exemplified in the writings of historians, economists, military commentators and others, is responsible for the fact that the subject receives no mention in the schemes for revised university curricula aimed at the provision of a more balanced general education embracing both science and the humanities. Nor is it included in plans for the advancement and endowment of the social sciences. The pure scientist, too, rejects geography since (except in certain limited aspects) it is not susceptible of study by the method of controlled experiment. Yet departments of geography are over-full, and chairs in geography multiply faster than they can be effectively filled. Ordinary people are recognizing that the regional differentiation of the world's surface (although they would not thus define it) lies behind some of our most crucial problems, and is at the root (for example) of the effective reduction of the number of Great Powers to two.

The causes and consequences of regional differentiation can only be understood in relation to the globe viewed as an organic whole. The concept of 'global thinking' goes back among geographers to the late eighteenth century traveller von Humboldt. As thus envisaged, geography shares with sociology the methodological difficulties arising from the impossibility of isolating 'pure' problems, with the consequent need to call upon a number of diverse skills and specialisms. The present climate of thought is, however, unfavourable to group research (employing specialists from different fields) and even to team research (employing specialists within the same field), and successful examples of such work are few. Nevertheless archæologists, historians, economists, sociologists and physical planners have recently shown an increasing disposition to seek the collaboration or advice of geographers, no doubt because, now that a second generation of trained geographers is coming to maturity, the output of work reaching an acceptable standard of scholarship is increasing. Examples of such work with a particular social bearing include analyses of the geographical circumstances of 'problem' areas—the Italo-Jugoslav boundary, Palestine, the march-lands of Russia, the 'special areas' of Britain—studies in micro-climatology, in coastal morphology, in land-utilization, areas of urban circulation and influence, and so on. The value of maps, not merely as a means of exposition, but also as a tool of research, is also increasingly appreciated.

A world war has for the second time emphasized the need for 'terrain' geography and exposed the gaps in geographical knowledge. New methods of air photography—stereoscopic survey, colour and infra-red photography—are capable of supplying data by which those gaps could be rapidly filled. The interpretation of such data occupied many geographers during the Second World War. Beach reconnaissance, involving a land, sea and air complex, as a preliminary to military landings, called for novel methods of research, and led to new knowledge of shore-line processes and coastal morphology. The use of rockets and unpiloted aeroplanes lends a new importance to exact knowledge of the shape and dimensions of the geoid. The need for popular education in world geography lays upon geographers the duty of designing maps and globes which give a world picture appropriate to an 'air age'.

PROGRESS IN MODERN ENGINEERING

Civil engineering aspects of progress in modern engineering is the principal topic of the presidential address to Section G (Engineering) by Sir William Halcrow. An analysis of engineering evolution involves consideration of mental conditioning in the past as well as of achievement. Society as a whole did not become mechanically minded until after the First World War, and the progress was slow. American influence is considerable, and we must understand the conditions which have led to their lavish use of machines and materials. Reference to the progress of prime movers, of constructional materials, and of some recent developments in technique follows.

The steam engine has been highly developed for many years; but the steam railways require considerable improvements to cater for modern traffic intensities. The great operational inflexibility of the system can only be relaxed by changes in track layout, signalling systems and dead weight of stock.

Steam turbines are our main prime mover for the generation of electricity. Fuel ancillaries are inherently heavy and bulky, however, and the gas turbine, which will soon be in economical operation in aircraft, may challenge the steam turbine on these grounds. At present, however, its life is too short for purely industrial purposes.

The water turbine has been highly developed for some considerable time. Intensive hydro-electric development is taking place in the Highlands of Scotland; but the great Severn Barrage tidal scheme still awaits official approval. With 800,000 kW. installed capacity, it could produce some 2,300 million units of electricity per annum at 0·2*d.* per unit and save one million tons of coal a year.

Our mechanical civilization did not attain a high rate of development until the latter half of the nineteenth century, when iron and steel could be produced in large quantities. The present century has seen the great development of alloy steels, and we may be approaching the end of the age of simple mild steel. The use of light alloys has greatly increased, and it is not generally realized that aluminium production depends entirely on large amounts of cheap hydro-electric power.

Modern cement dates from about 1850; and although its chemistry is still not fully understood, high grades are available in large quantities. A recent advance is the production of low-heat cement. The use of reinforced concrete is widespread, and latterly the technique of pre-stressing has resulted in considerable savings in materials in some cases.

Earthwork has only been scientifically treated since the early 1920's, when Dr. Terzaghi began to publish his penetrating analyses. Some problems still await solution, but we understand their limits and tendencies. Tunnelling is highly mechanized at present and rapid progress is possible. In soft ground, by use of a shield, a 12-ft. Tube railway tunnel in London clay can be advanced by as much as 160 ft. a week.

Prefabrication was used on a large scale for marine works during the War; for example, in the well-known invasion harbours and the lesser-known permanent military ports in some of the Scottish sea lochs.

We have had to develop analysis by experimental methods to a considerable pitch. Electrical resistance strain gauges and photo-elastic methods are useful. In aircraft the piercing of the sonic barrier depends greatly on model and wind-tunnel research. In hydrodynamics, models are most useful for determining hull forms, wave action, silting and erosion in harbours, spillways of dams and similar problems.

ANTHROPOLOGICAL APPROACH IN SOCIAL SCIENCE

In his presidential address to Section H (Anthropology), Prof. C. Daryll Forde discusses the anthropological approach to the social sciences. The social sciences are often regarded as comprising all scholarly studies contributing to the portrayal of social conditions, including historical or descriptive accounts and those directed towards the solution of practical social problems. But more strictly considered, science seeks to establish valid generalizations concerning the properties of a range of natural phenomena, and its precision and explanatory value depend on the accuracy with which these properties are determined and the relations between them established. In this sense, social science must be concerned with the investigation of the nature and conditions of social relations, and should seek valid generalizations concerning variation in the social life of the human species. Interpretations of particular societies past or present, and predictions as to particular social developments in the future, depend for their penetration and reliability on achievement in this more strictly scientific field. This dependence of advance in descriptive and practical studies on the development and application of theory is generally recognized in the field of economics, but has been less readily appreciated by students of social history, politics and ethnology.

Anthropology, traditionally concerned with the study of savage or pre-literate peoples, has developed in response to historical and practical, as well as scientific, interests. But interest in the organisation of these small-scale societies has been considerably stimulated by the hope of obtaining therefrom greater insight into problems of our own civilized societies through a better understanding of universal processes in the social life of man. The comparative study of the whole range of social forms is required for the formulating and testing of fundamental hypotheses concerning the nature of society. As in other scientific fields, advance is often easier with reference to less complicated material provided by small-scale 'primitive' societies. Moreover, the novelty and variety of institutions and social relations in such societies direct attention to problems which tend to be obscured by the particular conditions and conventional definitions current in our own society.

Anthropological studies in the field of culture have traditionally included both descriptive or ethnographic and analytical or sociological studies. It is important to recognize that as in other fields of knowledge, developments in each are interdependent. The scientific study of the social organisation of small-scale societies depends on the analysis of ethnographic data. Ethnography in turn has been rendered intrinsically more adequate and coherent by advances in sociological theory which have posed new questions and provoked new methods.

Thus earlier descriptions of societies organised in wide uni-lineal kin groups, of which only formal and ceremonial features were commonly emphasized, left obscure the processes whereby such groups were formed and maintained, and failed to reveal their role in maintaining social coherence and control among peoples where there is little specialization of activity and status. Analysis of rights and status in ritual, economic and political spheres has led to the discovery of a high degree of segmentation at a series of levels within these and other corporate bodies in other small-scale societies, and has revealed opposed tendencies to solidarity and fission within such groups as part of the adaptive character of social structure in relation to ecological conditions.

The study of corporate activity and leadership in small-scale societies shows that processes which in more complex societies are expressed in specialized religious, economic and political institutions are not absent among the former, but operate through less differentiated, multifunctional organisations. The categories of economics, religion, law and government are found to have wider reference and more variable inter-relations than is commonly recognized from the study of Western societies.

From the internal analysis of particular societies, and comparative studies, the range of conditions in which specialized institutions emerge are being more closely determined. Spencer's hypothesis of social evolution greatly stimulated the development of social anthropology in the nineteenth century. The comparative study of institutions in relation to the total social structure on one hand, and the ecological foundations of social life on the other, promises to yield a theory of social development more valid than the unverifiable speculations concerning the social conditions of early man into which interest was temporarily diverted in the nineteenth century.

WIDER APPLICATIONS OF TEACHING OF PHYSIOLOGY

THE main feature of Prof. Winifred Cullis's address to Section I (Physiology) is a plea for the training of more physiologists and a wider use of their services. Physiology, if it is to take its proper place in education, has a dual function to perform. Its importance in the teaching of medical students is well recognized; but there is too little appreciation of its other aspect as a science which, apart from its medical bearing, is important for the general health of the community. A plea for a wider recognition of this aspect was chosen for the address, not only because Prof. Cullis's war-time experience broke her contact with the more academic side of physiology, but also because in her opinion it is one insufficiently recognized and one in which she is able to draw upon personal experience.

The community owes much to physiology and is interested in hearing of this debt. The newer knowledge of nutrition, with which will always be associated the name of Sir Frederick Gowland Hopkins, has shown its use in dealing with the restrictions imposed by war-time conditions. The story of insulin, itself of great interest, has a special value in these days of popular writings, in giving some idea of the time that may elapse between the making of a discovery and its safe and general application. The decision of the men of Smithfield not to increase the price of pancreatic material, after hearing what this material could mean in giving to diabetic patients the chance of an active life, is a dramatic instance of the value of knowledge. Possibly, too, a better knowledge of physiological principles might enable the public to evaluate more correctly some of the fantastic claims made in advertisements of certain preparations.

Well-qualified teachers of physiology would be of use in many directions. They are much needed in the general training colleges as well as in those devoted to the training of teachers of domestic science and of physical training. They would be of great value in schools in the upper forms, where they could build upon the foundations often so well laid in the junior forms by good biology teaching. In these institutions and in industrial establishments they could be of use in collecting the normal physiological data now recognized as necessary in the departments of social medicine. Social science workers would be helped by such instruction, and in extra-mural university classes and in adult education such teachers could play an important part.

To provide these teachers it will be necessary for the universities to increase the number of students taking honours courses in physiology, but who are not going on to medicine. It will also be necessary for the various educational institutions to realize the value of having on their staffs teachers so trained.

In schools, broadcasting and films can be useful aids, though they in no way lessen the responsibility of the class-room teacher, from whom the main inspiration must always come. In preparing such aids it is necessary to have co-operation between three sets of experts, the class-room teacher and the experts in the subject and in the medium to be used. It is necessary, too, for teachers to have training in the of such use aids.

It is Prof. Cullis's firm conviction that this wider teaching of physiology would result in a better understanding of various problems intimately associated with healthy living, so leading to a higher and better standard of health for the individual.

MAN'S ADAPTABILITY

THE question of the adaptability of man was the theme of Dr. S. J. F. Philpott's address before Section J (Psychology). Many of the problems psychologists have handled during the War and that will face them during the peace have had to do with man's adaptability. Can a bank clerk be changed, almost overnight, into a tank gunner ? Can he be changed back by a stroke of the pen ?

If the doctrine of round pegs in round holes were strictly true such transformations would be difficult, if not impossible. In practice, they can take place with surprising ease, especially if the will to act is present. There are limits. Broadly speaking, men are only adaptable within the limits of their all-round ability; but granted the will and the ability, man can play many parts.

In asking just how an individual is equipped and just how he can adapt himself, we must realize that he works as a whole. When in the workshop planing or sawing a piece of wood, it is my body as a whole that I use, throwing it now into the attitude appropriate to the use of a plane, now into the attitude appropriate to the use of a hand saw. I do not use a planing organ or a sawing organ.

In similar fashion, I am now in the mental attitude appropriate to making an abstract. In a moment I may be in the frame of mind appropriate to making some calculations, or writing a letter, and so on. It is my mind as a whole that I use in each of these operations. I do not use an abstracting organ or a calculating organ.

The problem of education into a given culture is that of giving the individual an enormous number of such attitudes, skills or techniques, ranging from the simplest of everyday actions like opening doors up to the highest expression of the arts and sciences. We only begin to realize the significance of the complex of skills thus built up when we learn about 'wolf children' realizing how much they have lost. Yet no matter how complex the result of all this training, it still remains that all activities can be traced to the functioning of the one general-purposes body-mind instrument.

The problem of drill arises whether in peace or war. It is that of making these various techniques automatic. One cannot enjoy riding a bicycle until all movements of hands and feet and body take place well below the conscious level. No man can be master of his craft until he has made himself a slave to the minor habits involved, the fingering of his instrument or the handling of his tools.

Before advising training, we often to-day apply tests of potentiality. The naïve view is that we ought to be able to devise tests to distinguish between those born to be tank gunners and those born to be tank drivers. In fact, a one-time carpenter can often succeed at either of the other two occupations. Granted that at the moment he knows nothing about either of them, will tests for potential drivers or potential gunners pick him out ? If so, will it not be a case of a test for drivers picking out a potential gunner ? Or so far as that goes, will it not have picked out an actual carpenter ? Put briefly, although it is easy to devise tests of all-round ability (trainability or adaptability) it is quite another matter to discover tests that shall assess potentiality in respect of some one occupation and it alone. There is wide overlap. The bearing of this on problems of peace, such as that of advising children into the best form of education, is obvious.

THE HISTORY OF PLANT FORM

ALTHOUGH in recent years botanists have been mainly interested in the study of growing plants, many of their generalizations are based on a belief that evolution has taken place in the plant world. But since very little historical evidence of the evolution of the flowering plants has been forthcoming, this belief has become a dogma, maintained in spite of the absence of proof. This unsatisfactory position, said Dr. H. Hamshaw Thomas, in his presidential address to Section K (Botany), warrants a survey of our present knowledge of the fossil record.

Past failure to find any clues to the early history of the flowering plants may be due to a deductive examination of the evidence. The logical basis of evolutionary study is different from that of pure or typological morphology, but it has been assumed that the *Urform* of the pure morphologist represents the primitive type of flowering plant. Consequently we may have been searching for structures which have never existed. The actual record of changes in plant form through the ages suggests the evolution of the angiosperms through types very different from those imagined.

The geological record becomes clearer if we compare the plant forms from successive *terrestrial* periods, dividing the geological time-scale in a manner complementary to the normal classification of strata, the groups of which represent periods of marine sedimentation. Owing to the rare conditions under which plants are preserved as fossils, we can never hope to trace real phylogenies, but we can obtain evidence of the ways in which structures have changed in the past 400 million years.

The remains of the Upper Silurian–Lower Devonian land plants show forms widely different from the plants of to-day. Types with smooth forking axes predominated; they had little differentiation into stems, roots and leaves. During the Middle Devonian period there were leaves of several types which seem to be derived from specialized photosynthetic branches. A variety of large, much divided fronds appears in the Upper Devonian–Lower Carboniferous rocks; their ultimate segments were usually small or narrow. Several of them belonged to seed-bearing plants—the pteridosperms. In Upper Carboniferous–Lower Permian times this group had more compact fronds, with larger, partly concrescent pinnules; reticulate venation appeared in some genera. Among these, *Gigantopteris* approaches the type of leaf now characteristic of dicotyledons. Petrified stems with a wide range of structure have been found; some of them suggest an approach to angiospermous structure.

The sequence of reproductive structures forms a coherent series which should be studied without reference to morphological preconceptions. Most of the earlier types had their sporangia on the ends of fertile branches, often in groups. This habit continued through Upper Palæozoic times. Kidston described six different forms of pteridospermous pollen-bearing structures from the Lower Carboniferous, with terminal groups of radially arranged sporangia, and Halle has investigated a number of similar structures from the Upper Carboniferous. All are constructed on the same general plan, which is also seen in the male flowers of many unisexual angiosperms to-day. These structures, as well as the cupulate seeds, generally grew on special branch systems. Halle's suggestion is recalled, that in one line of pteridosperm evolution the plant body was differentiated into a vegetative and a reproductive region, the spore-producing members congregating to form some kind of inflorescence or flower borne directly on branches of the stem and not on leaves. The Triassic pteridosperms from South Africa had dichasial inflorescences and support this view. Another link between the pteridosperms and the angiosperms is provided by certain rare and undescribed fossils from the Molteno beds of South Africa. These show inflorescences of a dichasial type, bearing small flowers with delicate perianth segments.

The closed ovary of the angiosperms may have been derived from the open cupules of the pteridosperms. The Jurassic *Caytonia* suggests how the closure may have come about, and Prof. Doyle's researches on pollination and fertilization in the conifers are interesting in this connexion.

Traces of flowering plants occur in the Upper Jurassic and increase in number until they form more than 90 per cent of the floras in the Eocene rocks. The widely different types present in Cretaceous beds suggest that the group must have originated in Upper Palæozoic or early Mesozoic times. An investigation of the spore content of freshwater sediments may throw light on this suggestion. A high percentage of the families represented in the Upper Cretaceous–Lower Tertiary floras show primitive characters in their secondary wood; by statistical analysis, Sporne has been able to discover other characters probably possessed by the more primitive dicotyledons.

All these studies are independent of morphological theory, and since plant morphology has developed as a deductive study they suggest that a reconsideration of its concepts are necessary. The War showed the importance of a complete and objective analysis of information as a basis for action. This is a principle applicable both to the problems which have been here considered, and to all the affairs of national life.

EVOLUTION OF SECONDARY EDUCATION

In her presidential address to Section L (Education), Miss Lynda Grier discusses "The Evolution of Secondary Education in Britain". The most notable features in the evolution of secondary education in Britain have been, she said, the growth and constant power of the classical tradition, and its decay; the growth of democracy, including the growth of the woman's movement; the coming of science with a new conception of humanism in education, and the interest in technical education.

The dominance of classics in education in the first instance was due to the fact that they were useful and paved the way to office in Church and State, that they were necessary to lawyers and diplomatists, won favour at court, and were, in brief, the main requisite for any who wished to enter the learned professions. Conservatism kept classical teaching powerful when the direct usefulness of the classics had ceased, and brought about a decline in the number of grammar schools, and in the numbers at the universities, until the latter began to take note of the new learning, and it was slowly recognized that education should have some connexion with the world in which men and women had to live. This recognition was due to the growth of democracy and the increasing need of the sciences for the contribution of learned thought and training. As these things came to the fore, secondary education began slowly to take its rightful place in men's minds as something that should be offered to all children.

Early democratic ideas in education in England, unlike those of Commenius, were selective and concerned with the provision of ladders for the poor and able, which would set them side by side with the rich, or even, as some of the most democratic of early English thinkers suggested, above the rich, if the rich were not worthy of the education offered. Hence the English system was profuse in scholarship provision, generously but definitely selective. Interest in the higher education of women suffered an even greater decline than did that for men, until the gradual emergence of a true democracy.

Mathematics and science were not neglected entirely, for indeed much fine work was done in both. But it was carried on outside the universities and grammar schools; and schools of a different type were set up for their teaching, or else, as suggested by Locke, they were taught by private tutors, until at last the ancient universities began to recognize their importance. Technical education, which should long since have come into an important place in education, given the decay of apprenticeship and the competition of other countries, has only recently established its claims in the provision of secondary education.

The general neglect by the State of secondary education in Britain allowed for great variety in it, since what was done was in the hands of private bodies and individuals with widely different points of view. The recent Education Act and all the interpretations given to it by the Ministry of Education recognize the value of that variety. In achieving for the first time a complete system of education, with secondary education for all, it is recognized that unity is incompatible with uniformity, and that the greater the variety the more perfect can be the result.

SOILS AND HEALTH

THE effect of soil conditions on plant and animal health forms the topic of Dr. W. G. Ogg's presidential address to Section M (Agriculture). Great advances have been made in this subject during the past quarter of a century. One of the most interesting discoveries is the part played by what are termed the trace elements from the fact that traces only are normally required. Some of these appear to affect plants only; others both plants and animals; and yet others, animals only. Deficiencies or excesses of these substances have been shown to be responsible for a wide range of plant and animal diseases and cause large annual losses to the agricultural industry. Probably the sub-clinical cases are far more numerous than those with obvious symptoms of disease, and are responsible for even greater losses. We do not know very much about the way in which the trace elements act, but possibly they are catalysts.

Although these trace-element diseases are spectacular and highly important, the major plant foods have a much greater influence on the food supplies and health of the community, and deficiencies of these are much more widespread.

It is obviously of very great importance to agriculture to have as much information as possible about the natural distribution and availability of both major plant foods and trace elements. Much of our knowledge on this subject is due to the geochemical studies of the late V. M. Goldschmidt. He developed improved methods of quantitative spectrography which have been of great value in obtaining the necessary analytical data, and his work on crystal chemistry has thrown much fresh light on the distribution of the trace elements in the earth's crust.

The introduction of fertilizers about a century ago has led to an enormous increase in food production throughout the world. It is not claimed that they have supplanted organic manures. Both have their uses and they should be regarded as complementary. Apart from other considerations, fertilizers are needed if the world's food supply is to be maintained because of the shortage of organic manures.

Violent attacks by some of the enthusiasts for organic manures have been made on the use of fertilizers. It is claimed that they poison the soil and are detrimental to the health of plants, animals and human beings. There is no good evidence in support of these assertions. Far from doing harm, fertilizers, properly used, build up soil fertility. In fact, by enabling larger crops to be grown, they increase the amount of material which can be converted into farmyard manure, and the greater amount of roots and other crop residues also increases the organic matter in the soil. For the same reason they are beneficial rather than detrimental to the soil's population of earthworms and micro-organisms. Nor is there sound evidence in support of the assertion that fertilizers increase the liability of crops to insect, fungus or virus attack, or that they have a detrimental effect on the composition and quality of agricultural produce.

Probably more can be done for the improvement of health in the world to-day by providing ample supplies of food than in any other way, and the propagation of unfounded beliefs about the harmful effects of fertilizers is detrimental to the interests of the whole community.

LOCAL SCIENTIFIC SOCIETIES

AS in many other fields, there is a tendency to take stock, and there has been a suggestion, both expressed and implied, that the day of the local society is past. The Council of the British Association has had the matter under consideration and has circularized its corresponding and affiliated societies asking for detailed information on certain points and for suggestions. The replies have been collated, and the president of the Conference of Delegates of Corresponding Societies, Dr. J. Ramsbottom, made them the basis of his address with the intention of promoting discussion.

Local societies had their origin for the same purposes as the so-called learned societies and even as the old universities—the dissemination or communication of knowledge and the furthering of research. Gresham College, 1596, with its endowed lectures, and the foundation of the Royal Society in 1660, show how in the sixteenth and seventeenth centuries these objects were met. With the advance in learning in the eighteenth century and the realization of the benefit of mutual exchange of ideas, many literary and social clubs met in London coffee-houses and taverns, and larger literary and philosophic societies were founded in different large provincial towns—Edinburgh 1731, Manchester 1781, Newcastle 1793, and so on. Specialized societies began to make their appearance with headquarters in London: the Linnean Society 1788, the Geological Society 1807, Zoological Society 1826 and Entomological Society 1833.

The natural history society may be considered a product of the Victorian era. It was essentially an association of people interested in nature study at a period when systematic botany and zoology were generally regarded as the main part of these subjects. Many of our local Floras and Faunas were due to their activities, and much of real value was published on other branches of biology.

At the present time, most local societies carry on much in the way which was so profitable up to fifty years ago. Since then there has been a crop of societies and clubs dealing with special branches of biology; but the *omnium gatherum* local natural history societies continue, though many cannot be said to flourish. Some, under the stimulus of one or more members, have tended to specialize, but undue specialization defeats its own ends; sections acting as local branches of the larger societies dealing with these subjects would be more profitable. The federation of local societies into regional unions, beginning with the Yorkshire Naturalists' Union, 1877, has proved advantageous and stimulating; but there is need for some collaboration between the unions themselves.

Most natural history societies lament their small membership, particularly the absence of young members. Their enrolment is a task of national importance, for the country will need an increasing number of trained biologists, and it is beyond question that field work is the most profitable method of approaching many fundamental problems as well as inspiring a true interest in biology.

The compilation of records has always been carried on by local societies, and with the possibility of the increase in the number of nature reserves there is opportunity for detailed studies on a broad ecological or biological basis. Indeed, the local natural-history societies might play a large part in protecting these areas and in noting others that are worthy of local or national preservation.

NEWS and VIEWS

Physiology at University College, Dundee: Prof. G. H. Bell

Dr. George Howard Bell, who has been appointed to the chair of physiology in University College, Dundee, is a graduate of the University of Glasgow, where he had a distinguished career in both the Faculty of Science and the Faculty of Medicine, gaining the M.B. degree with honours in 1930 and, later, the higher degree of M.D., also with honours. For the thesis which he presented for the latter degree he was awarded a Bellahouston Gold Medal. After graduation, Dr. Bell spent a period in clinical appointments before entering upon an academic career in physiology, and he has always maintained a close interest in clinical problems. He gave a considerable amount of voluntary hospital service during the War. A year ago he was elected a fellow of the Royal Faculty of Physicians and Surgeons of Glasgow. Prof. Bell's career as a physiologist began with his appointment as an assistant in the Glasgow University Institute of Physiology. This assistantship was followed by a lectureship at the University of Bristol, after which he returned to Glasgow as senior lecturer in physiology. His research interests have been concerned in the main with problems in the physiology of parturition and of reproduction in general; with the significance of capillary fragility tests; and, most recently, with the effect of various factors on the physical strength of bone. Many of these studies are notable for, and indeed have depended for their success upon, the development of new techniques and on the design and construction of novel apparatus; and quite apart from strictly physiological research, Dr. Bell has issued many valuable papers on new and improved methods and apparatus, and on the application of nomograms to physiological and clinical calculations. His practical text-book on experimental physiology has gained acceptance not only in Glasgow but also in several other medical schools.

Physical Chemistry at Durham: Prof. W. F. K. Wynne-Jones

Prof. W. F. K. Wynne-Jones, professor of chemistry at University College, Dundee, University of St. Andrews, has been appointed to the chair of physical chemistry at King's College, Newcastle-upon-Tyne, University of Durham, in succession to Prof. H. L. Riley (see *Nature*, Dec. 14, 1946, p. 867). Prof. Wynne-Jones is a D.Sc. of the University of Wales, having begun his academic career at University College, Aberystwyth; later he went to Oxford. He continued his chemical studies with Brönsted at Copenhagen, and spent some time with H. S. Taylor at Princeton University as a Leverhulme scholar. After having held appointments in the Universities of Bristol and Reading, he went, in 1938, to Dundee. During 1942–44, he took over the duties of head of the Chemistry Department of the Royal Aircraft Establishment, Farnborough; and during the War he also supervised electro-chemical research work, which was carried out at University College, Dundee, for the Ministry of Supply. Prof. Wynne-Jones' main research work has been in the field of chemical kinetics. He has worked on acid-base catalytic reactions in solution, and on electrolytic dissociation processes. His work also includes studies in the role of solvent in reaction kinetic processes, and on the effect of isotope exchange on reaction-rates, particularly the exchange of deuterium and hydrogen.

American Awards for British Men of Science

Dr. H. Roxbee Cox, director of the National Gas Turbine Establishment and chairman and managing director of Power Jets (Research and Development), Ltd., has been awarded the American Medal of Honour with Silver Palm for "meritorious service to the Government of the United States from September 1941 to September 1945, in connection with the development of turbo-jet and turbine aircraft engines. Dr. Roxbee Cox contributed to a great extent to the successful prosecution of this major war project by establishing and effectively administering an efficient system of technical collaboration between the British and U.S. Governments."

Dr. E. Talbot Paris, principal director of scientific research (defence) in the Ministry of Supply, has been awarded the American Medal of Freedom with Bronze Palm for "meritorious service during the period of action in the field of scientific research development. As a physicist in the Ministry of Supply, he was responsible for the development of radar communications and other electronic equipment required for the ground forces of the British Army. He took an active part in establishing the interchange of scientific information with American laboratories, contributing substantially to the development of highly technical equipment."

Exhibition at the National Gallery

On October 8 the National Gallery is re-opening a suite of six rooms, the first to be completely redecorated since the War. Many of the pictures to be shown in these have been re-framed. Nearly all will be shown without glass; though they will be protected by low barriers of silk cord. Fluorescent lighting is being installed in all the rooms. In one of them the walls will be covered with loose hangings of damask. These are all experiments towards the method of exhibition to be adopted in another suite of rooms, now half derelict, which is to be completely remodelled and air-conditioned. The pictures hung in five of the redecorated rooms will be the seventy which have been cleaned during the last ten years. In order of cleaning, they will begin and end with the two portraits of King Philip IV by Velázquez. In date they will range from the fourteenth to nineteenth centuries. The exhibition will show the cleaned pictures together for the first time, on clean backgrounds. Examined under these conditions, and with the help of a few demonstration pictures, 120 comparative photographs, X-radiographs, etc., and a catalogue giving the relevant facts, it will be possible to assess the correspondence on the subject which has appeared in the Press during recent months.

South African Science

The first issue of the newly established monthly journal, *South African Science* (*Suid-Afrikaanse Wetenskap*), has just been published (Vol. 1, No. 1, August 1947). This is the bulletin of the South African Association for the Advancement of Science and is available free to members, but may be obtained also by non-members (15*s*. a year, including postage, Kelvin House, H/v Marshall and Hollard-straat, Johannesburg). The journal is similar to *Nature* in format and make up. There are two valuable main articles: "Scientific Research in South Africa", by Dr. B. F. J. Schonland, president of the South African Council of Scientific and Industrial Research, and "The World View of the Physicist", by Prof.

H. H. Paine. Letters to the Editor and Notes and News are given reasonable space, and there is a further article, "The Control of Reverberation in Theatres and Concert Halls", by Prof. P. R. Kirby. An account of the Oudtshoorn meeting of the South African Association completes the number. The editor of *South African Science* is Dr. H. B. S. Cooke, of the Department of Geology, University of the Witwatersrand, who is to be congratulated on the first number of a journal which is clearly needed in such a rapidly developing area as South Africa.

The Indian Archives

The Indian Archives, the first number of which, dated January 1947, has just been received, is a welcome addition to periodical literature on documentation and to the specialist journals of India; its high quality is assured by the fact that it is published by the Imperial Record Department at New Delhi on behalf of the Indian Historical Records Commission. Since the establishment of the Imperial Record Department in 1891 and the Records Commission some thirty years later, much has been achieved, as reference to their many publications will show, in the collection and systematic classification, calendaring and indexing of the Government of India's extant records and in the technical work of their proper care and preservation. But much remains to be done. There are still many districts in India with an untold wealth of valuable archives in charge of unqualified keepers, and some Provinces and States without central record offices. India is not the only country that has in the past been indifferent to the value of its historical records. There, as elsewhere, healthy signs exist of an awakening of the public conscience, and the new journal is intended not only to stimulate this but also to serve as a clearing house for scientific knowledge on matters of archival interest and as an advice and information centre for Indian archivists. The editorial board proposes to print important articles on archival subjects from the foreign press as well as original contributions and papers dealing with India's special problems. This first number has a very interesting selection; it is well produced and will be well received by all concerned with archives and their keeping. It is to appear quarterly.

A New Mycological Periodical

The well-known periodical *Annales Mycologici*, beginning in 1903, ended with its forty-second volume. The premises of the publisher were destroyed in an air attack in April 1945, and H. Sydow, the editor and founder of the journal, died in the following year. Dr. F. Petrak, the eminent mycologist of the Vienna Museum, has decided to re-start the journal with the title *Sydowia*. It will retain its international character and will appear twice a year, each number containing 12–15 sheets. The first number is to be published this year and will include some papers by Petrak which were contained in Nos. 3–6 of Vol. 42 of the *Annales*, the whole edition of which was destroyed. Mycologists are invited to send original articles for publication in English, French, German, Italian, Latin or Spanish. The price of each volume will be 40 Swiss francs. The publisher is Ferdinand Berger, Horn, Nied.-Österreich; the editor, Dr. F. Petrak, Botanische Abteilung des Naturhistorischen Museums, Vienna, Austria. British mycologists will wish Dr. Petrak success in his venture.

Chymia

The great interest shown in the United States in the history of science is to find a further expression in the inauguration towards the end of this year of an annual publication on historical chemistry, entitled *Chymia*. It is anticipated that each volume will contain about a dozen articles of some four to five thousand words each, written in various languages and contributed by leading authorities from all over the world. It is appropriate that *Chymia* should be sponsored by the Edgar Fahs Smith Memorial Collection at the University of Pennsylvania, for it was in this University that the first American chair of chemistry was established in 1769, in the Colonial period, and filled by Benjamin Rush, one of Joseph Black's earliest pupils at Edinburgh. The editor-in-chief of *Chymia* is Prof. Tenney L. Davis, with a board of five other American editors and a group of consulting editors of international repute, representing, to date, the United States, Great Britain, France, Switzerland, Sweden, Holland, Germany, the Argentine, Brazil and China. The British contributors to the first volume are Prof. J. R. Partington, Prof. John Read and Dr. F. Sherwood Taylor. The secretary of the editorial board is Miss Eva V. Armstrong, curator of the Edgar Fahs Smith Collection, University of Pennsylvania, Philadelphia. Publication in Britain will be undertaken by the Oxford University Press.

Summer School in Physical Chemistry at Cambridge

Designed to bring industrial research into closer contact with academical research, an eight-day course of lectures and class work was opened in the Department of Physical Chemistry at Cambridge on August 16. The pressure of applications induced the organisers to accommodate 180 rather than the 100 applicants originally contemplated. An unexpectedly high number of representatives came from university colleges, technical colleges and schools. Many officers attended from the research departments of the Ministry of Supply, and some from the Services. The majority were drawn from industrial organisations, headed in by a group of twenty-six from various sections of Imperial Chemical Industries, Ltd. Prof. Norrish's inaugural lecture on the history of chemistry at Cambridge was followed by eighteen lectures given by him and his staff and devoted in equal numbers to molecular structure, its quantal interpretation, its optical investigation and its bearing on pure liquids and solutions; polymerization, oxidations, explosions, photochemical reactions and nuclear chain processes; the mechanism of friction, wear and lubrication, and the induction of chemical change by impact. The course was characterized by a friendly exchange of difficulties between those attending the school and those responsible for it, and by the variety of new experimental techniques available for trial. The final meeting was attended by the Vice-Chancellor and addressed by Mr. A. V. Alexander, Minister of Defence.

Libraries and their Use

Some of the papers read at the week-end conference of the London and Home Counties Branch of the Library Association held at Eastbourne in October 1946, which have now been issued as a separate reprint (Library Association, 68 Holloway Road, London, N.7. 5*s*.), although addressed primarily to the public librarian, are of interest to those in charge of scientific or technical libraries and to those using such libraries for research or for other purposes. This applies particularly to the papers in the symposium on special materials in libraries, to which Dr. E. C. Willatts, of the Ministry of Town and Country Planning, contributes some notes on the cataloguing, classification and handling generally of maps, plans and aerial photographs, and Miss D. Tayler, formerly of the Ministry of Information, on the like treatment of pictorial material. Mrs. L. Moholy surveys the various processes of documentary reproduction, including the photostat process and micro-copying techniques, and urges once more the establishment of central offices of documentary reproduction; while two papers by Miss Marie T. Slocombe and Miss Valentine Britten, both of the British Broadcasting Corporation, dealing with sound recordings and describing the B.B.C.'s Recorded Programmes Library and the formation and administration of a gramophone library, respectively, should interest a more limited number of scientific workers. An excellent paper on "Library Co-operation and Publicity", by C. A. Elliott, of the Bermondsey Public Libraries, makes many sound points which could well be laid to heart by the works librarian or the librarian serving a research organisation in industry or elsewhere. The two-fold responsibility is the same: to provide an adequate service and to make it accessible. As in the public library, there is the task of organising an efficient service to meet known needs, of removing all unnecessary hindrances and barriers between the reader and the source of information, and of making known, continuously and effectively, the existence of the service so that it is fully used.

Beilby Memorial Awards

From the interest derived from the invested capital of the Sir George Beilby Memorial Fund, at intervals to be determined by the administrators, representing the Royal Institute of Chemistry, the Society of Chemical Industry, and the Institute of Metals, awards are made to British investigators in science to mark appreciation of records of distinguished work. Preference is given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy, and awards are made, not on the result of any competition, but in recognition of continuous work of exceptional merit, bearing evidence of distinct advancement in science and practice. In general, awards are not applicable to workers of established repute, but are granted as an encouragement to younger men who have done original independent work of exceptional merit over a period of years. The administrators of the Fund will therefore be glad to have their attention directed to outstanding work of the nature indicated not later than November 1. All communications should be addressed to the Convenor, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Information on Solar Activity by Radio

As the central station for international co-operation on solar activity, the Swiss Federal Observatory at Zurich is now giving monthly the daily sunspot (relative) numbers by the short-wave service of the Swiss Broadcasting Corporation according to the following programme:

On the 4th of each month:

	G.M.T.					
(1)	07h.20m.	wave-length	25·39	25·28		for Australia
(2)	15 05		19·60	16·87		,, the Far East
(3)	21 50		19·59			,, South America
(4)	22 30		25·28			,, North America
(5)	23 40		31·46	25·28	19·59	,, South America

On the 5th of each month:

	G.M.T.					
(6)	01h.40m.	wave-length	31·46	25·28	19·59	for North America
(7)	03 05		31·46	25·28	19·59	,, North America

For this year, in October, emission 2 will be on October 3 instead of October 4. Emissions 3 and 5 are in Spanish, the others in English.

The Night Sky in September

New moon occurs on Sept. 14d. 19h. 28m., U.T., and full moon on Sept. 30d. 06h. 41m. The following conjunctions with the moon take place: Sept. 10d. 11h., Mars 3° N.; Sept. 12d. 10h., Saturn 4° S.; Sept. 19d. 10h., Jupiter 0·6° N. Mercury and Venus are badly placed for observation during the month and Venus is in superior conjunction on Sept. 3. Mars, in the constellation of Gemini, is visible in the morning hours, rising a little before 0h. during the greater portion of the month. Jupiter, in the constellation of Libra, can be observed in the early part of the night, setting at 21h., 20h., and 19h. 20m. at the beginning, middle, and end of the month, respectively. Its stellar magnitude varies between − 1·6 and − 1·4 during September. Saturn can be seen in the constellation of Leo in the morning hours, rising at 3h. 05m., 2h. 20m., and 1h. 34m., at the beginning, middle, and end of the month, respectively, and is easily recognized by its yellowish hue. Only one occultation of stars brighter than magnitude 6 takes place: Sept. 28d. 01h. 42·5m., τ Aquar.(*D*), the latitude of Greenwich being assumed and *D* referring to disappearance. The autumnal equinox occurs on Sept. 23d. 21h.

Announcements

The Committee of Privy Council for Medical Research has appointed Prof. N. Hamilton Fairley, professor of tropical medicine in the University of London, and Prof. J. H. Gaddum, professor of materia medica in the University of Edinburgh, to be members of the Medical Research Council as from October 1.

The Paint Research Association will celebrate its twenty-first anniversary on Tuesday, September 23 and following days, and the Paint Research Station, Teddington, will be open to visitors. On September 25 Sir Thomas Merton will give a short address, followed by a lecture by Dr. D. A. Sutton entitled "Is Copal Varnish an Alkyd?"; on the next day Sir Lawrence Bragg will speak, and will be followed by a lecture by Dr. G. Herdan entitled "Paint and Mathematics". Applications to visit the Station should be sent to the Director, Paint Research Station, Waldegrave Road, Teddington, Middlesex.

The twenty-second annual conference of the Association of Special Libraries and Information Bureaux will be held at the London School of Economics during September 20–21. The topics to be discussed include the effect of atomic energy developments on scientific and technical publication (Prof. R. E. Peierls); punched card systems in library work (Dr. J. W. Perry, Dr. W. E. Batten and Dr. G. M. Dyson); and format of periodicals (Dr. V. E. Parke, L. J. F. Brimble and L. G. Patrick). Particulars of the meeting can be obtained from the Secretary of the Association, 52 Bloomsbury Street, London, W.C.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effect of Testicular Hormone on the Formation of Seminal Fructose

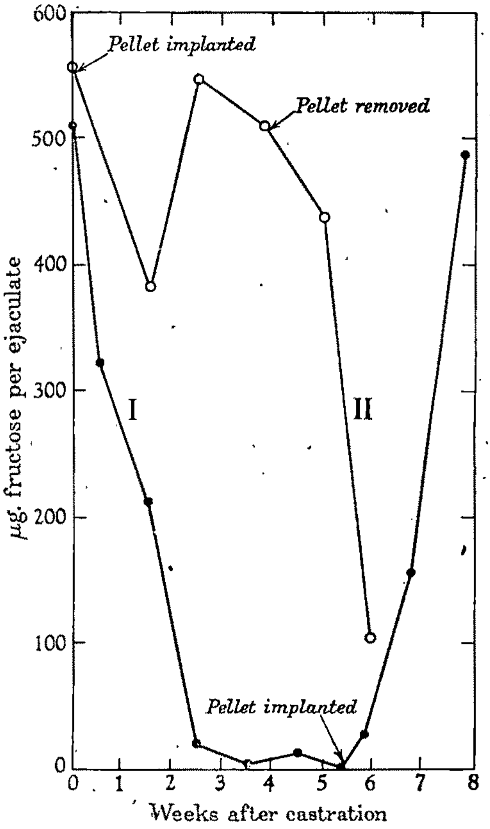
PREVIOUS experiments have established the fact that mammalian semen contains fructose, its concentration varying from a few mgm. per cent in boar to 1,000 mgm. per cent in bull; this sugar serves the spermatozoa as their natural nutrient, and they readily metabolize it[1,2]. At the site of its origin in the testis, and in the epididymis, the semen contains very little fructose but acquires it during its passage through the male generative tract, from the accessory glands of reproduction, mainly the seminal vesicles[3].

In the course of experiments designed to solve the mechanism of fructose formation in the accessory glands, we have now found that the process of fructose generation is linked in a striking manner with the action of the testicular hormone and, furthermore, that characteristic fluctuations in the level of seminal fructose can be evoked in response to testosterone. For the investigation we have used sixteen fully fertile bucks; some of them were castrated, while the others were used as controls. The collection of semen was carried out at weekly intervals by the method of Macirone and Walton[4]. Fructose was determined by the method previously described, using 0·1 ml. samples of semen and 0·05–0·2 gm. samples of the various tissues[3].

EFFECT OF TESTOSTERONE ON FRUCTOSE CONTENT IN ACCESSORY GLANDS

	Gl. vesicularis and seminalis		Prostate	
	Weight mgm.	Fructose mgm. %	Weight mgm.	Fructose mgm. %
Non-castrated buck	780	62	860	79
1 week after castration	860	84	590	18
2 weeks after castration	680	5	410	5
5 weeks after castration	420	3	540	3
8 weeks after castration and simultaneous implantation of testosterone pellet (100 mgm.)	1100	29	1170	71

Within the first two or three weeks following castration, there was a remarkable fall in the fructose content of accessory glands, and usually by the end of the second week the organs were almost completely depleted of fructose. This post-castrate fall in fructose, however, could be prevented by the implantation of pellets of pure testosterone under the skin of the castrated animals (see table). An even clearer picture was obtained through the study of the effect of testosterone on the level of fructose in the semen itself, as illustrated in the accompanying graph. Castration caused a sharp decrease in both the volume of ejaculates as well as in the concentration of fructose in semen, so that the actual quantity of fructose per ejaculate, which normally amounts to some 500 μgm., dropped within three weeks following castration to less than 20 μgm., remaining low until a pellet of testosterone was implanted. In response to testosterone, there was an increase in the volume of ejaculates together with a rise in fructose which soon reached the pre-castration level (Curve 1). In presence of the pellet, a high concentration of fructose could be maintained in the castrated animal for several weeks. However, when the pellet was removed, a significant fall in seminal fructose was registered again (Curve II). From these results we are inclined to conclude that testosterone is the hormone responsible for the formation and maintenance of fructose in semen.



It has long been known that the weight, size, histological appearance and secretory function of certain accessory organs, notably the seminal vesicles and prostate, are strictly dependent on, and closely regulated by, the internal secretion of the testes; and that the typical retrogressive changes which develop in the accessory glands after removal of the testes can be counteracted by injections of the testicular hormone, thus serving as 'indicator tests' for the male hormone. To these biological tests may now be added the highly sensitive 'fructose test' whereby the testicular hormone can be conveniently assayed in castrated animals, simply by examining the fructose content of the semen or of the accessory glands. It may be added that the post-castration fall in the level of fructose and its restoration by testosterone occurs more rapidly and is much more marked than the rather slow and gradually developing gross morphological changes in the accessory glands of reproduction.

This work has been carried out on behalf of the Agricultural Research Council. We are grateful to Dr. J. Hammond, Mr. J. Hammond, jun., Prof. D. Keilin and Dr. A. Walton for placing the experimental animals at our disposal, for help and advice, and to Dr. W. J. Tindall, Organon Laboratories, for a gift of pure testosterone.

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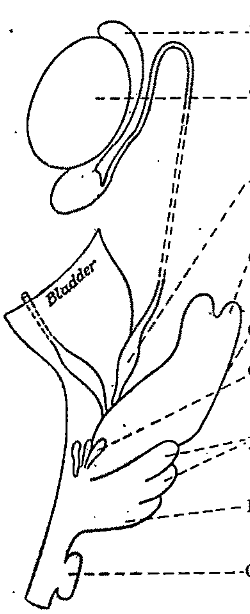
Functional Development of Accessory Glands and Spermatogenesis

WHEN fructose was established as the normal nutrient material for spermatozoa and its origin traced to the seminal vesicles[1], it remained to be explained how certain animals, such as the rabbit, secrete fructose in semen in spite of the absence of seminal vesicles. The rabbit, however, has a large complex organ, sometimes referred to as the 'prostate', which has been described hitherto as composed of three glands, 'gl. seminalis', 'gl. vesicularis' and 'prostate proper', each with an independent urethral outlet[2]. However, our recent investigation of the development of the male reproductive system in the rabbit has established that the gl. seminalis develops in conjunction with the gl. vesicularis from the same diverticulum of the Wolffian duct; further, both glands possess a common urethral outlet, and gl. vesicularis as a whole, rather than the gl. seminalis by itself, should be regarded as homologous to the seminal vesicle in other mammals[3]. This, incidentally, explains the presence of fructose in the gl. vesicularis. It should be pointed out, however, that in the rabbit, apart from this gland, fructose also occurs in the ampulla of the vas deferens as well as in the 'prostate proper'. The distribution of fructose in the various parts of the reproductive system of the male rabbit is shown in the accompanying sketch.



	Weight of organ (mgm.)	Fructose in organ (mgm.)	Fructose (mgm./100 gm. tissue)
Epididymis	600	0·03	5
Testis	2900	0·06	2
Ampulla	130	0·03	23
Gl. seminalis	150	0·04	26
Gl. vesicularis	920	0·79	85
Gl. paraprostaticæ	190	0·092	48
Prostate I and II	335	0·368	110
Prostate III	475	0·272	57
Cowper's gland	1000	0·0	0·0

In the course of investigations on the development of the reproductive system in the rabbit, we noticed that fructose appeared in the accessory glands at an early stage when there was as yet no sign of active spermatogenesis. In a four-months-old animal, both the gl. vesicularis and the prostate showed already a fairly high concentration of fructose (21 and 44 mgm. per cent, respectively) in spite of the complete absence of spermatozoa in the testis or the epididymis. When, in the sixth month of life, the spermatozoa finally made their appearance, the accessory glands were filled with secretory fluid containing the normal high level of fructose. Experiments on bull-calves gave similar results, showing that the appearance of fructose in the secretory fluids of the accessory glands precedes the onset of active spermatogenesis.

Thus it appears that the male reproductive organs first accumulate a store of nutrient material, so that when the motile spermatozoa make their appearance in the generative tract, the fructose reserve is available, ready to be utilized. Together with the recent finding that the formation of seminal fructose requires the presence of the testicular hormone[4], our experiments provide additional evidence that the testicular hormone begins to function in the body some time before actual spermatogenesis.

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Oxidation of Insulin by Performic Acid

FROM the determination of the terminal residues of insulin, it was suggested that the submolecule of molecular weight 12,000 is made up of four peptide chains bound together by —S—S— linkages[1]. Thus if one could break the —S—S— linkages without affecting any other part of the molecule, it should be possible to split the insulin into its separate polypeptide chains, two of which have terminal glycyl residues and the other two phenylalanyl residues. Toennies and Homiller[2] showed that the only amino-acids that are appreciably oxidized by performic acid are tryptophan, methionine and cystine, the latter reacting with five atoms of oxygen and presumably forming cysteic acid. Since insulin contains no tryptophan or methionine, this seemed a suitable way of splitting the —S—S— linkages.

Using the procedure of Toennies and Homiller, it was found that the oxidation of cystine to cysteic acid is complete in five minutes. With insulin an oxidation-time of 15 minutes was generally used. The oxygen consumption was the theoretical one for the cystine content, and paper chromatography[3] showed no qualitative difference in the amino-acid composition except the replacement of cystine by cysteic acid. There was no destruction of the free amino-groups[1]. The oxidation product was studied in the electrophoresis apparatus of Tiselius. Unfortunately, it was not possible to dialyse the material, due to its low molecular weight (about 3,000), so that the results were not always entirely reproducible. Fig. 1 illustrates a typical experiment, which shows three components and indicates that the mixture is not unduly complex.

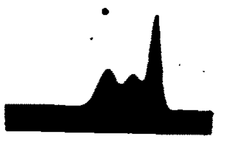

Fig. 1. ELECTROPHORETIC DIAGRAM OF OXIDIZED INSULIN

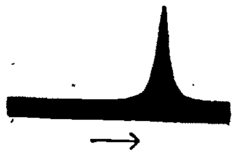

Fig. 2. ELECTROPHORETIC DIAGRAM OF FRACTION *A*

By neutralization at *p*H 6, two fractions of about equal weight can be obtained. The solution (fraction *A*) contains predominantly (80 per cent) glycyl terminal residues, and the precipitate (fraction *B*) predominantly phenylalanyl terminal residues. By further treatment of fraction *A* a product can be obtained which has no phenylalanyl terminal residues and appears to be homogeneous by electrophoresis (Fig. 2). It contains no lysine or arginine. Estimation of the terminal glycyl residues suggested a molecular weight of about 2,500. Fraction *B* has not yet been further purified.

The work is being continued, and a more detailed report will be published later.

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Malonate and Plant Respiration

SINCE Quastel and Whetham's discovery in 1925[1], biochemists have come to regard the malonate ion as one of the very few specific enzyme inhibitors—as a competitive inhibitor of succinic dehydrogenase[2]. Malonate has therefore been widely used with animal tissue, in work designed to elucidate the Krebs cycle. Recently it has also been applied to plant tissues, but with discordant results. Machlis[3] showed that malonate inhibited part of the respiration of barley roots; but several other workers have independently stated that malonate does not inhibit and may even stimulate plant respiration[4-7].

In 1938, Turner[8] pointed out that the apparent differential effect of iodoacetate on respiration and fermentation was probably explicable in terms of the different rates of penetration of the drug into the cells, under aerobic and anaerobic conditions. In spite of a general increase in our knowledge of cell permeability, this aspect of work with inhibitors and living tissue is still neglected. It is highly probable that the reported lack of inhibition of plant respiration by malonate is due simply to the use of the malonate ion instead of the malonic acid molecule as a cell penetrant.

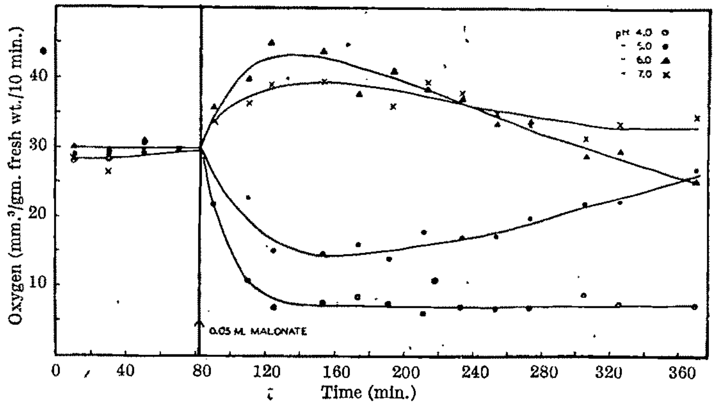

FIG. 1. REACTIONS OF TISSUE RESPIRATION TOWARDS POTASSIUM MALONATE SOLUTIONS OF INCREASING ALKALINITY. UNDISSOCIATED ACID IN SOLUTION: *p*H 4, 98%; *p*H 5, 84%; *p*H 6, 33%; *p*H 7, 5%. CARROT TISSUE, 308 HOURS FROM CUTTING

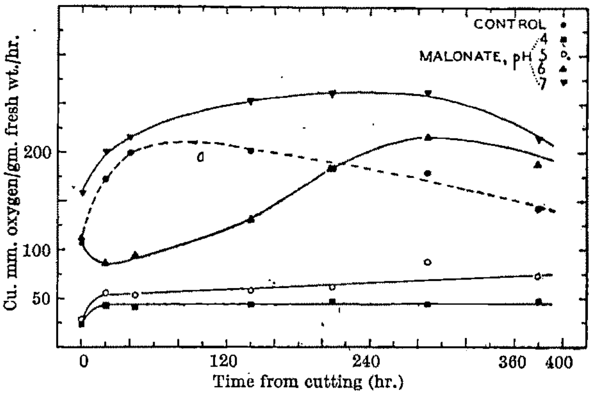

FIG. 2. DRIFT OF RESPIRATORY RESPONSES OF CARROT TISSUE TOWARDS POTASSIUM MALONATE SOLUTIONS, WITH TIME FROM CUTTING. THE VALUES PLOTTED ARE THE MINIMUM (OR MAXIMUM) RATES OF OXYGEN UPTAKE ACHIEVED IN THE SEVERAL EXPERIMENTS

In work with tissue slices of carrot root we have found (Figs. 1 and 2) that potassium malonate (0·05 *M* in distilled water) at *p*H 4·0 causes inhibition of that fraction of the respiration which is inhibited by cyanide[9]. The malonate effect at *p*H 4·0 therefore supports the view of Marsh and Goddard[10] that the cyanide-sensitive respiration in carrot is mediated by the cytochrome-oxidase system, for this is coupled with succinic dehydrogenase.

At *p*H 4, about 98 per cent of undissociated malonic acid is present and might be expected to penetrate cell membranes rapidly. As shown in Fig. 1, very different results are obtained if malonate is applied at *p*H 5, 6 or 7, rather than at *p*H 4. At *p*H 7·0, when only 3 per cent of the undissociated acid is present, the potassium malonate causes a clear stimulation of the oxygen uptake. Because of the associated *R.Q.* effects, we provisionally assign this stimulation to the effect of the potassium ion in bringing about an 'Ulrich' effect, that is, a shift in the balance of the organic acids which leads to an increased respiration-rate[11]. Malonate effects at *p*H between 5·0 and 7·0 (but not at 4·0) vary markedly with the period of time that elapses between the cutting of the slices and the experiment (Fig. 2). For example, at *p*H 6·0 (33 per cent molecule) malonate applied to freshly cut tissue produces a clear-cut but partial inhibition of the cyanide-sensitive respiration. If the tissue is first washed in distilled water for 300 hours, the malonate causes stimulation of the respiration; if the tissue is washed for only about 200 hours, the malonate has no effect whatever upon the rate of oxygen uptake. These curious effects are difficult to explain at present; but at least they emphasize once again the fact that freshly cut tissue slices differ remarkably from long-washed, 'aged' slices in their physiological behaviour[12].

Where the authors who have noted no inhibition of plant respiration by malonate have stated fully their experimental technique, it is usually possible to explain their results in terms of the facts recorded above. Malonic acid appears to enter the cell membrane at an appreciable rate only as the undissociated molecule. As the actual enzyme inhibitor is probably the malonate ion, it is to be presumed that the succinic dehydrogenase of plant cells is not located on the outer cell membrane as was suggested for bacteria by Quastel.

We have extended this work to red-beet tissue, which was stated by Bennet Clark and Bexon[4] to be insensitive to malonate. We find that the effects of malonate on beet-tissue slices are closely similar to those recorded in Figs. 1 and 2 for carrot. There is one interesting difference. Malonic acid at *p*H 4·0 causes inhibition of the cyanide-sensitive respiration[13] of beet tissue, but (for well-washed tissue only) the rate of oxygen uptake later rises again to a value above the normal rate, after which there is once more a sharp decline. Simultaneously, the cells lose and oxidize some of their vacuolar pigment. We explain this additional complexity as due to the loss of cell organisation leading to non-respiratory oxidation of cell contents.

Although *p*H changes *per se* have some effects on respiration-rates, they can be shown not to be responsible for the malonate effects described. For example, succinic acid produces its greatest stimulatory effects at *p*H 4·0. The increased respiration brought about by this and other organic acids is inhibited by malonate at the same *p*H (4·0), both in carrot and beet tissue. However, results in this laboratory make it doubtful whether malonate acts, *in vivo*, only as an inhibitor of succinic dehydrogenase. Our experiments to date indicate that its inhibitory effect is not reversed by high succinic concentration, or even by fumaric acid.

We are indebted to Dr. R. N. Robertson, with whom we have discussed this problem. This work will be published in full elsewhere.

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Raphanin, an Antibacterial Principle of the Radish (*Raphanus sativus*)

IN the course of investigation of the watery extracts of different plants by the cylinder plate method on plates seeded with *Staphylococcus* and *Bact. coli*, it was found that the extracts of the seeds of radish (*Raphanus sativus*) gave a very marked zone of inhibition in both cases, whereas the extract of the root and the leaves did not affect the growth of the bacteria. The antibacterial principle of the extract was resistant to heat, and it could even be boiled on a water-bath for 30 minutes without a marked loss of activity. The substance responsible for the activity was isolated from the water extract of the seeds, and a syrupy liquid was obtained of boiling point 135° C. under 0·06 mm. mercury pressure, which could be distilled as a homogeneous substance. The almost colourless, or slightly yellow, distillate proved to be the active antibacterial principle, and has been termed 'raphanin' by us. As it was estimated on the basis of antibacterial tests, 1 kgm. of the seeds contains about 6–8 gm. of this active principle, the yield of the raphanin on isolation being about 3 gm. per kgm. of seeds.

The raphanin is freely soluble in water, ethanol, butanol, butyl acetate, amyl acetate and chloroform. It is moderately soluble in ether, and very slightly soluble in petroleum ether. The products from different batches proved to be identical, and on elementary analysis raphanin was found to have the following percentage composition: C 41·44, H 5·33, N 8·65, S 33·64. Calculated percentage composition for $C_{17}H_{28}N_3O_3S_5$: C 42·48, H 5·45, N 8·74, S 33·35; and for $C_{17}H_{26}N_3O_4S_5$: C 41·11, H 5·28, N 8·58, S 33·03.

The raphanin is neutral and optically active: $[\alpha]_D^{20°}$ in ethanol being − 141°. The solution of the active principle does not give the recognized test as recommended by Jacobs and Hoffman[1] for unsaturated lactones. When the watery solution of raphanin was heated with the salts of heavy metals, for example, silver nitrate, a great bulk of metal sulphide was precipitated, and the antibacterial action was lost. The antibiotic was not inactivated by cystein. The raphanin is stable between *p*H 3 and 8, but above this is readily decomposed. On shaking with 0·1 *N* baryta at room temperature and neutralizing the excess alkali with sulphuric acid, an inactive crystalline substance was obtained on standing the solution in an ice-chest. This inactive substance, sparingly soluble in water and in organic solvents, was recrystallized in ethanol and the recrystallization repeated in water; m.p. 192–193° C. (uncorr.) at decomposition. The inactive substance contains: C 34·65 per cent, H 5·30 per cent, N 6·73 per cent, and S 45·37 per cent. Formula $C_6H_{11}ONS_3$ requires: C 34·45, H 5·30, N 6·69, S 45·95 in per cents.

When tested by the cylinder plate method on plates seeded with different Gram-positive and Gram-negative bacteria, a solution containing 1 mgm. of raphanin per ml. gave a zone of inhibition in mm. as follows: *Staphylococcus aureus*, 18; *Bact. coli*, 16; *Sal. typhi-H*, 19; *Sal. typhi-O*, 24; *Sal. schottmülleri*, 22; *Bact. Shiga-Kruse*, 16; *Pseudomonas aeruginosa*, 19; *Bact. anthracis* (avirulent), 23; *Bact. anthracis* (virulent), 22; *Bact. subtilis* (strain 'Duthie'), 20; *Bact. prodigiosus*, 12.

Raphanin is highly active in preventing the germination of the seeds of different plants. This kind of effect, which was called by Köckemann[2] the blastokolin effect, is shared by different lactones, particularly by coumarine[3]. A 1 : 1,000 solution of the raphanin prevented germination of the seeds of *Festuca pratensis*, *Brassica oleracea*, *Sinapis alba*, *Cucumis sativus*, *Hordeum distichon*, etc. At a concentration of 1 : 10,000 germination was retarded, and the length of the root was markedly reduced by the end of the third day. Raphanin did not, however, significantly influence the germination of the seeds of radish even at a concentration of 1 in 1,000.

The substance proved to be moderately toxic; 10 mgm. doses given intravenously killed mice, whereas after doses of 5 mgm. mice appeared markedly unwell but recovered within a short time. The perfusion of the isolated frog's heart with raphanin at a concentration of 1 in 800 caused slowing of the heart, relaxation of the tone and amplitude. This effect showed itself within five minutes and progressed until the heart stopped. After perfusing with Ringer's solution there was recovery of the amplitude, but the pulse-rate remained depressed. A concentration of 1 : 8,000 of the substance did not affect the contraction of the heart.

The growth of tissue cultures from rabbit testicle[4] was hindered by raphanin even at a considerable dilution. A concentration of 1 : 20,000 of the antibiotic prevented entirely the growth of the explants, and a dilution of 1 : 40,000 caused diminished growth of the fibroblasts, as compared to that of the controls.

We are indebted to Prof. V. Bruckner and Dr. J. Kovács for carrying out the elementary analyses.

Full details of these observations will be published elsewhere.

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Thiamine of Milled Raw and Parboiled Rice

IT has long been known that the vitamins of cereals are not evenly distributed throughout the grain but are concentrated mainly in the outer coats and in the germ, which consists of the embryo and attached scutellum.

Analyses of the meals and flours of the miller have been somewhat misleading because some mixing of the products from different parts of the grain takes place within the mills. Dr. J. J. C. Hinton, of the Cereals Research Station at St. Albans, dissected cereal grains, accurately separating the different structures, and determined the vitamin content of each structure. He reported[1] that there was a surprising concentration of thiamine in the scutellum of wheat, and that although it forms on an average only 1·54 per cent of the grain, yet it contains 59 per cent of all the thiamine present in the grain. In a later paper[2] he recorded that the scutellum of rye, maize and barley had similar very high contents of thiamine.

This is an important matter in respect of rice milling, for it is probable that rice is not an exception and that much of the thiamine is concentrated in the scutellum. Rice is either milled raw or it is milled after parboiling. Many analyses have shown that parboiled rice is richer in thiamine than highly milled raw rice, and this agrees with the experience that beriberi is very rare or does not occur where parboiled rice is the staple article of diet.

It has generally been accepted that parboiling distributes the vitamins of the pericarp and germ throughout the whole grain, and therefore milling can remove only a small amount with the bran. Recently, I have examined a large number of grains from several samples of raw milled rice and parboiled rice. The great majority of the grains of raw rice had a concavity marking the site from which the whole germ (scutellum and embryo) had been detached. On the other hand, the grains of parboiled rice did not show the concavity; but the site of the germ was flattened as though only part of the germ had been removed by milling. It appeared as though parboiling had made the scutellum more adherent, so that it had not been detached during milling.

Hinton[2] found that twelve hours soaking of wheat did not cause any movement of the water-soluble thiamine to the rest of the grain. He suggested that the cells of the scutellum are not permeable to water until they have been acted upon by acid chloroform or some other agent. Possibly also the high fat content of scutellum may be a bar to the penetration of water.

Parboiling and also the new conversion process, which is parboiling first under vacuum and then under pressure, toughens the rice so that far fewer grains are broken during milling than in the case of raw rice; this lowering of brittleness would help the retention of the scutellum. Probably parboiling does cause some movement of the vitamins within the grain; but its chief value may be the retention of the scutellum.

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Marking Mosquitoes with Fluorescent Compounds and Watching them by Ultra-Violet Light

A TECHNIQUE for marking mosquitoes with fluorescent compounds and watching them by ultra-violet light has been developed, to study the movements of these insects at night without affecting their normal behaviour. The method seems very promising and opens out possibilities for the study of the ecology and bionomics of mosquitoes hitherto not possible.

Zukel[1] used fluorescent compounds to detect marked insects in a large number of specimens, but no attempt was made to develop the technique to observe the insects at night under natural conditions. For this purpose investigations were carried out to ascertain: (*a*) the sensitivity of mosquitoes to shorter wave-lengths, (*b*) whether the insects can take up sufficient dust on their bodies to fluoresce brightly, (*c*) the toxicity of fluorescent compounds to insects, (*d*) whether it would be possible to watch the dusted insects at night by ultra-violet light, and what would be the normal range of visibility.

Mosquitoes, unlike some other insects (honey bees and *Drosophila*), are not sensitive to the ultra-violet radiations of wave-lengths given out by the lamp used (4070–3130 A., 95·5 per cent being concentrated at 3650 A.). Both positive and negative reactions were compared to the behaviour in ordinary light. The species studied were *Anopheles maculipennis* var. *atroparvus*, *Culex molestus* and *Aëdes ægypti*.

Mosquitoes take up sufficient dust to fluoresce brightly, and the dust does not shake off for a number of days. The fluorescent compounds have apparently no toxic effect on these insects as judged by their survival for more than one and a half months after dusting. The dusted insects fluoresce very brightly and can be watched at a distance of about ten feet.

The fluorescent compounds used were anthracene, 'Photophour' and standard 'Mazdalux' powders P_2, P_4 and P_{4xx}, P_5 and P_{5xx}, and P_7, giving bright blue, green, yellow and red fluorescence. The ultra-violet lamp used was a 125-watt 'Mercra' lamp with a concentrating reflector. The dusting procedure is very simple. The mosquitoes are placed in a glass chimney and given a few puffs of the fluorescent dust by means of a hand duster. Aqueous suspensions of fluorescent compounds in spirit gum or slightly soluble dusts in standard cobalt salt solution are not recommended, as the spray accumulates on the wings only and the fluorescence is comparatively poor.

It has not been possible to develop an apparatus capable of working from a 6–12-volt battery; the standard 'Mercra' lamp used in these experiments works on 220 volts A.C.

I should like to thank the British Thomson-Houston Co., Ltd., for the loan of the apparatus, for supplying fluorescent compounds and for other technical assistance.

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'Evaporation' of Heavy Nuclei

THE behaviour of atomic nuclei under very high excitation can at present only be studied by examination of the nuclear disintegration 'stars' produced by high-energy cosmic ray particles. Below is given a brief account of results obtained in a preliminary examination of Ilford Nuclear Research emulsions exposed to the cosmic radiation.

Measurements have been made on the energy distribution of particles from the disintegration of fifteen heavy nuclei (silver and bromine), out of a total of some two hundred stars found on 400 sq. cm. of plate area. A star was assumed to be due to a heavy nucleus if the ejected particles carried a total charge of more than eight units, and was only accepted for measurement if at least one long proton track ended in the emulsion, so that the latent image 'fading' could be allowed for in determining track energies from grain counts.

In Fig. 1 the histogram indicates the energy distribution of a total of eighty star proton tracks. Such tracks in $B2$ and $C2$ emulsions become very difficult to detect at energies greater than 100–200 MeV.; hence the stars may well include protons (and mesons) of too high energy to be observed; but at energies less than 100 MeV. the proportion of tracks missed in detailed examination of the stars is believed to be very small.

The process leading to the emission of particles may be visualized as follows. When the incident cosmic ray particle strikes the nuclear surface, its energy is divided in the first instant of time among only a few nucleons. In most cases, the latter will then interact with other nucleons and produce a general 'heating up', until 'thermal' equilibrium is attained. The disintegration process is then analogous to the evaporation of a drop of liquid, and particles are ejected under arbitrary angles, as in Fig. 2. In the case of fairly heavy nuclei, an approximate theoretical treatment of the problem is possible from a thermodynamic point of view, and the energy spectrum of charged particles evaporating from a highly excited nucleus in 'thermal' equilibrium at temperature T is given by[1]

$$P(E)dE = \text{const.}\ \frac{(E - V)}{T^2}\ \exp\left\{\frac{-(E - V)}{T}\right\} dE, \quad (1)$$

where V is the potential barrier height. The value of T drops during the evaporation; also, the temperature depends, though fortunately not very critically, on the excitation energy, which will be different for every star. The average value of E from (1) is

$$\overline{E} = 2T + V, \quad (2)$$

so that it is possible to obtain a mean value of $\overline{T}$ for all stars by using the experimental value of $\overline{E}$. Cutting off the observed spectrum at $E = 40$ MeV. (for reasons apparent below), one finds $\overline{E} = 13$ MeV. The experimental distribution is then reasonably well represented by equation (1), choosing $V = 3$ MeV., so that $\overline{T} = 5$ MeV. (dashed line in Fig. 1). From the proportion of protons at the low-energy end of the histogram, one can conclude that in these pro-

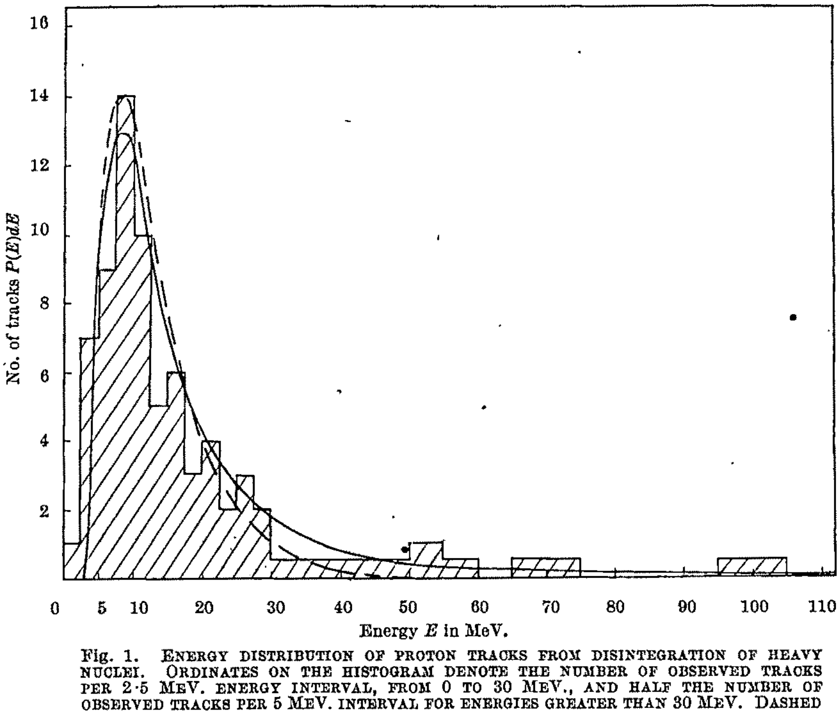

Fig. 1. Energy distribution of proton tracks from disintegration of heavy nuclei. Ordinates on the histogram denote the number of observed tracks per 2·5 MeV. energy interval, from 0 to 30 MeV., and half the number of observed tracks per 5 MeV. interval for energies greater than 30 MeV. Dashed and full curves correspond to equations (1) and (3)

cesses the barrier height is in any case a very ill-defined quantity ($V = 6$ to 7 MeV. from the nuclear radius, as obtained by alpha-decay measurements).

Some 9 per cent of the tracks are due to protons having energies greater than 50 MeV. (for example, track *B* in Fig. 2), whereas according to (1) such tracks should form only 0·2 per cent of the total. It is therefore clear that the high-energy 'tail' of the spectrum is not explicable on the Bohr evaporation hypothesis. At least three of the seven tracks in question have sufficient length in the emulsion to identify them as due to protons, and it seems unlikely that the remainder were produced by slow mesons[2]. According to Heisenberg, these high-energy protons are produced as follows. On being struck by the incident particle, some of the particles on the nuclear surface would be expected to have their velocities directed outwards, and will therefore leave the nucleus immediately with a very high energy (especially if the incident particle strikes the nucleus at a 'glancing angle').

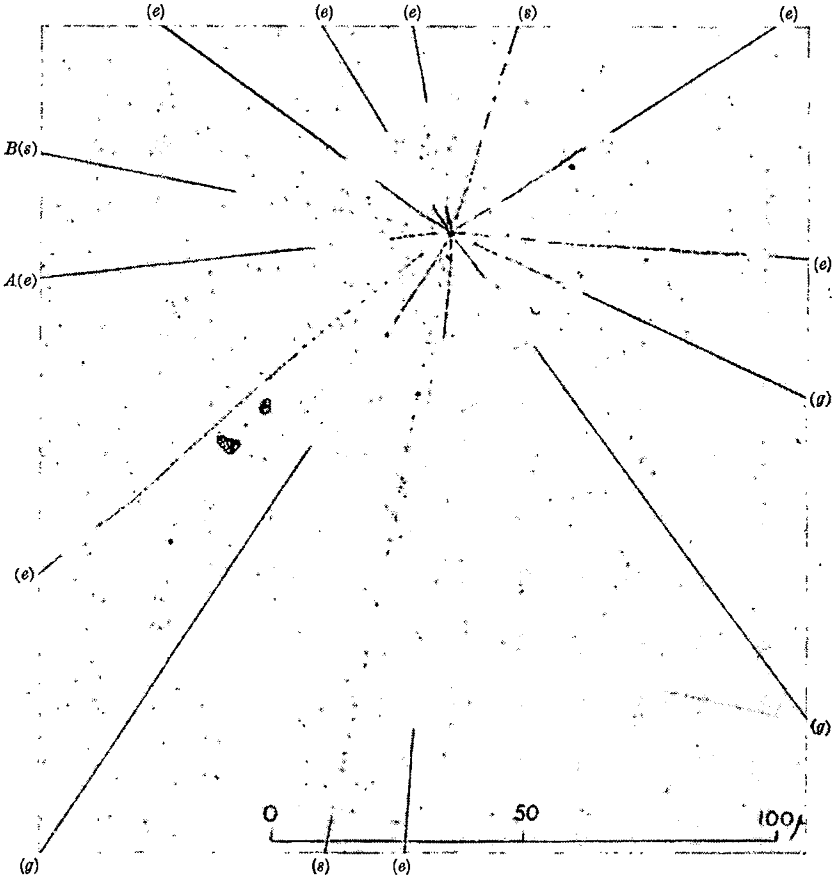

Fig. 2. MOSAIC OF 30 PHOTOMICROGRAPHS OF TYPICAL STAR IN 50 μ *C*2 EMULSION. LEITZ × 75 OBJECTIVE. AT LEAST 16 PROTONS, α-PARTICLES AND HEAVIER PARTICLES (ALL TRACKS NOT SHOWN) ARE EJECTED WITH VARIOUS ENERGIES BETWEEN 70 MEV. (TRACK *B*) AND 0·8 MEV. (TRACK *A*). TRACKS ENDING IN THE EMULSION DENOTED BY *e*, AND THOSE PASSING INTO THE GLASS OR OUT OF THE SURFACE BY *g* AND *s* RESPECTIVELY

It has been found that this high-energy tail of the histogram can, for example, be represented by an expression of type (1), and the spectrum indicated by the full line in Fig. 1 is given by

$$P(E)dE = \left[\frac{(E-V)}{\bar{T}^2} \exp\left\{\frac{-(E-V)}{\bar{T}}\right\} + \frac{1}{4}\,\frac{(E-V)}{\tau^2} \exp\left\{\frac{-(E-V)}{\tau}\right\}\right] dE \quad (3)$$

for the energy-range considered (0–100 MeV.). A value of τ of about $4\bar{T}$ (= 20 MeV.) gives the best fit. 8 per cent of the spectrum then lies at energies greater than 50 MeV. It is, however, difficult to associate τ with temperature, since the latter fundamentally implies an equilibrium state, which is certainly not attained, even though the Heisenberg process may conceivably include ten particles or so.

In addition to protons, about 25 per cent of the star tracks were due to alpha-particles; an accurate measurement of their energy distribution has not yet been possible, since the grain density along alpha-tracks changes only slowly with energy.

The average energy required to eject a proton or neutron from the nucleus is $\bar{E} + E_0$ ($E_0 = 8$ MeV. being the binding energy), so that assuming rather more than one neutron emitted for every proton observed, and including the alpha-particle tracks, the average value of the excitation energy $U \sim 300$ MeV.

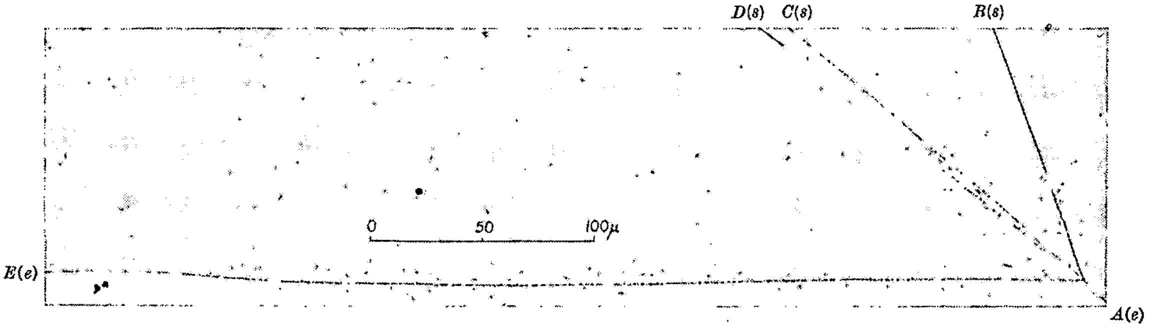

Fig. 3. MOSAIC OF 20 PHOTOMICROGRAPHS OF COLLIMATED TYPE OF STAR IN *B*2 EMULSION. TRACK *A*, RECOIL FRAGMENT; *B*, α-PARTICLE; *C* AND *D*, PROTONS OR α-PARTICLES; *E*, α-PARTICLE (ENERGY 36 MEV.)

The Fermi gas and liquid-drop models lead to considerably higher energies (500 MeV. or more) for $\overline{T} = 5$ MeV.

It is interesting to note that in the pure Bohr type of process the particles should be emitted under arbitrary angles; however, the angular distribution of tracks in a number of the stars show marked deviations from spherical symmetry, and probably these disintegrations are characterized by the fact that thermal equilibrium is never fully attained. Fig. 3 shows an extreme example of such a star. The probability that all four tracks were ejected under arbitrary angles is calculated as less than 1 in 10^6. However, since the recoil nucleus shows considerable momentum, and the ejected particles are of relatively low energy (20 or 30 MeV.), it is doubtful if this process is of the pure Heisenberg type, as observed in cloud chambers[3].

I should like to express my sincere thanks to Dr. J. L. Michiels, for a valuable discussion of the above material.

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Adsorption Isotherms from Chromatographic Measurements

IT has been shown[1] that adsorption isotherms can be calculated with good accuracy from chromatographic data, utilizing the measured concentrations (c_v) of eluted solute after developing the original band with v c.c. of pure solvent. Use is made of the equation

$$q = f_{(c)} = (\mu_c + v.c_v)/x_t - \alpha.c_v, \quad . \quad (1)$$

where q is the amount of solute adsorbed per gm. of adsorbent, x_t is the total amount of adsorbent in the column (gm.), α is the pore space of the adsorbent (c.c./gm. adsorbent), μ_c is the total eluate after the point of concentration c.

In the case of strongly coloured solutes, however, where the movement of the front boundary of the chromatographic band can be followed easily, it is simpler to obtain the adsorption isotherm from the volume v of pure solvent used and from the amount of adsorbent x_f through which the coloured front has travelled from the top of the column.

The position of the front is governed by equation 1 in the form:

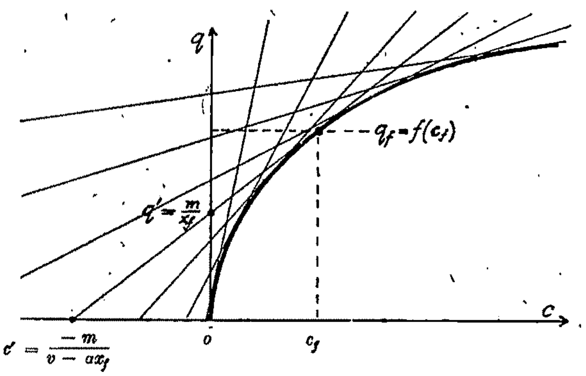
$$m = q_f.x_f - (v - \alpha x_f).c_f, \quad . \quad . \quad (2)$$

where m is the total amount of solute used. With m, v and x_f known, equation 2 represents a linear relationship between q and c with a gradient $dq/dc = (v - \alpha.x_f)/x_f$. However, as shown by De Vault[2] and by Weiss[3]

$$(v - \alpha.x_f)/x_f = [df_{(c)}/dc]_{c = cf}.$$

Thus equation 2, taken as a function of the variables q and c, corresponds to the tangent to the adsorption isotherm $q = f_{(c)}$ at the point q_f, c_f, and, with a sequence of coexistent values of v and x_f, equation 2 gives a family of straight lines, from which the adsorption isotherm can be easily constructed as the envelope.

The relative accuracy of the equilibrium values so obtained is approximately that of v and x_f, which, for a well-made column, can be determined to at least ± 1 per cent. This method thus gives the complete adsorption isotherm without requiring a single concentration measurement by just following the movement of the front boundary, and this with an accuracy at least equal to that of the best classical methods of measuring adsorption equilibria.



ADSORPTION ISOTHERM AS ENVELOPE OF THE FUNCTION $m = x_f.q - (v - a.x_f).c$

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Slip Flow in Granular Beds

THE Poiseuille type of equation for capillaries of any shape takes the form,

$$u_e = \frac{m^2}{k_0\eta} \cdot \frac{\Delta p}{L_e} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

for capillaries of any cross-section, where $k_0 = 2$ and $m = r/2$ for a circular capillary of radius r, and k_0 has generally values between 2 and 3 for other shapes[1]. Application of this to granular beds follows by putting $u = u_e \,.\, \varepsilon \,.\, L/L_e$, $m = \varepsilon/S\sigma(1-\varepsilon)$, $k = k_0 \,.\, (L_e/L)^2$, whence

$$u = \frac{\varepsilon^3}{(1-\varepsilon)^2} \cdot \frac{\Delta p}{k\eta S^2\sigma^2 L} \quad . \quad . \quad . \quad (2)$$

k is known as Kozeny's constant, and is approximately equal to 5 [1,2], Δp is pressure drop in dynes/cm.^{2}, and other symbols are as in the paper of Lea and Nurse[2].

When slip takes place in a capillary, giving a velocity, u_0, at the wall, this must be added to the right-hand side of (1). Now, by balancing momentum transfer and pressure difference, Millikan[3] obtained an expression for u_0 in a circular capillary in terms of a coefficient of external friction, β. In brief, tangential force on wall, $F' = 2\pi r L_e \beta u_0 = \pi r^2 \,.\, \Delta p$. This is readily generalized to non-circular capillaries, giving

$$u_0 = \frac{m}{\beta} \cdot \frac{\Delta p}{L_e} \quad . \quad . \quad . \quad . \quad (3)$$

The Poiseuille type of equation, corrected for slip, thus becomes

$$u_e = \frac{m^2}{k_0\eta} \cdot \frac{\Delta p}{L_e} \cdot \left(1 + \frac{k_0\eta}{m\beta}\right) \quad . \quad . \quad (4)$$

Millikan further showed that β is given by

$$\beta = \tfrac{1}{2}\, \rho\bar{c} \div \left(\frac{2}{f} - 1\right) \quad . \quad . \quad . \quad . \quad (5)$$

where f is fraction of molecules striking capillary walls which are diffusely reflected. Thus the slip correction factor $1 + k_0\eta/m\beta$ becomes

$$1 + \frac{2k_0\eta}{m\rho\bar{c}} \cdot \left(\frac{2}{f} - 1\right) \quad . \quad . \quad . \quad (6)$$

By substituting $m = \varepsilon/S\sigma(1-\varepsilon)$ this becomes a slip correction factor for granular beds,

$$1 + \frac{S\sigma(1-\varepsilon)}{\varepsilon} \cdot \frac{2k_0\eta}{\rho\bar{c}} \cdot \left(\frac{2}{f} - 1\right) \quad . \quad (7)$$

which must be multiplied into the right-hand side of (2). The first introduction of a slip correction factor of this form was made by Rigden[4], but he applied it in the form used for circular capillaries, for which $k_0 = 2$, whereas, for granular beds, k_0 appears to lie between 2·5 and 3, that is, the correction should be larger than that used by Rigden. Lea and Nurse[2] adopted the Chapman equation for viscosity, $\eta = 0{\cdot}5\ \rho\bar{c}\lambda$, where λ is molecular mean free path, in which case (7) takes the form

$$1 + \frac{S\sigma(1-\varepsilon)}{\varepsilon} \cdot k_0\lambda \left(\frac{2}{f} - 1\right) \quad . \quad . \quad (7a)$$

but wrote it in the form

$$1 + \frac{S\sigma(1-\varepsilon)\,Z\lambda}{\varepsilon} \quad . \quad . \quad . \quad . \quad (7b)$$

and evaluated Z experimentally, finding values between 2·73 and 4·07, averaging about 3·3.

By comparing (7a) and (7b), it can be seen that

$$Z = k_0\left(\frac{2}{f} - 1\right)$$

Now, Rigden used Millikan's value, $f = 0{\cdot}89$; but recently Brown, DiNardo, Cheng and Sherwood[5] have shown that $f = 0{\cdot}84$ is a more acceptable value in circular capillaries. It is of interest to calculate Z for both values of f and for $k_0 = 2$, 2·5 and 3.

$f \diagdown k_0$	2·0	2·5	3·0
0·89	2·50	3·12	3·75
0·84	2·76	3·45	4·13

Thus, on the whole, values of k_0 between 2·5 and 3 give better agreement with experiment than Rigden's assumption that $k_0 = 2$.

It is important to note here that there is no need to introduce a mean free path into (7), and that it is better to express it entirely in terms of experimental quantities by substituting

$$\bar{c} = \sqrt{\frac{8}{\pi} \cdot \frac{RT}{M}}$$

giving

$$1 + \frac{S\sigma(1-\varepsilon)}{\varepsilon} \cdot \sqrt{\frac{\pi M}{2RT}} \cdot \frac{k_0\eta}{\rho} \cdot \left(\frac{2}{f} - 1\right) \quad . \quad (7c)$$

It should also be noted that, if Δp is a large fraction of the initial pressure, u must be replaced by the mass velocity, $G = \rho u$, and equation (2) is easily shown to assume the form

$$G = \frac{\varepsilon^3}{(1-\varepsilon)^2} \cdot \frac{\rho_m \Delta p}{k\eta S^2\sigma^2 L}, \quad . \quad . \quad . \quad (8)$$

where ρ_m is the mean gas density before and after the bed and is equal to $\frac{1}{2}(\rho_1 + \rho_2)$. At the same time, ρ_m must be substituted for ρ in all the slip factors (7).

Molecular Flow of Gases in Granular Beds. When, in (7b),

$$\frac{S\sigma(1-\varepsilon)Z\lambda}{\varepsilon} \gg 1, \text{ that is, } \frac{Z\lambda}{m} \gg 1,$$

slip flow passes to molecular flow and the unity term in slip factors (7) can be neglected. Multiplying the second term of factor (7c) into the right-hand side of equation (8), we get

$$G = \frac{k_0}{k} \cdot \sqrt{\frac{\pi M}{2RT}} \cdot \left(\frac{2}{f} - 1\right) \cdot \frac{\varepsilon^2}{(1-\varepsilon)S\sigma} \cdot \frac{\Delta p}{L} \quad (9)$$

This differs from the equation put forward by Holmes[6] in two respects: (i) a factor k_0/k is introduced, which we have seen equals $(L_e/L)^2$ and appears generally to lie between 1·5 and 2. (ii) A factor $\sqrt{\frac{\pi}{2}} \cdot \left(\frac{2}{f} - 1\right)$ takes the place of $\frac{8}{3}\sqrt{\frac{2}{\pi}}$. Since Brown, DiNardo, Cheng and Sherwood find $f = 0{\cdot}77$ best fits molecular flow in circular capillaries, the two expressions are about equal.

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High-Frequency Permeability of Ferromagnetic Materials

IN view of the possibility of obtaining fuller information about the domain structure of ferromagnetics, by measurements of permeability at high frequencies, a method has been developed of measuring the effective reversible permeability of ferromagnetic materials in wire form over a fairly wide range of frequencies. A comprehensive review of earlier work has been given by Allanson[1], and apart from the early work of Arkadiew[2], who used a spark-gap source, no measurements of permeability have been recorded at frequencies higher than about 2,000 Mc./s.

Of the methods suggesting themselves for measurements at microwave frequencies, reflexion methods were found to be unsuitable[3] for metallic conductors, and the measurement of Q-factors of ferromagnetic films seemed to present experimental and theoretical difficulties.

In our method the permeability is deduced from measurement of the difference, $\Delta\alpha$, in the attenuation constant of a coaxial transmission line when the inner conductor, made of the ferromagnetic material under test, is replaced by a non-magnetic material of the same dimensions. It may be shown that

$$\Delta\alpha = \text{constant} \times \left(\sqrt{\frac{\mu}{\sigma_1}} - \sqrt{\frac{1}{\sigma_2}}\right),$$

where σ_1 and σ_2 are the conductivities of the ferromagnetic and non-magnetic materials respectively, and μ is the permeability.

The attenuation constants are determined from standing-wave measurements for different reactive terminations and are deduced directly from a circle diagram[4]. A pulsed oscillator is used to enable amplification of the rectified signal and accurate measurement of standing-wave ratios between 1 and 100 to be made. The method is rapid in operation and particularly suitable for use in the microwave region between about 2 and 20 cm. The present measurements, however, have been restricted to those frequencies for which suitable oscillators could be obtained.

Results have been obtained over the range from 8 to 14 cm., on a low-carbon content iron wire (0·04 per cent carbon), and a steel wire (0·50–0·55 per cent carbon), both specimens being tested in the hard-drawn (bright) condition and also after white annealing. Measurements have also been made with a commercial nickel wire (higher than 99·5 per cent nickel). The results, together with the D.C. initial permeabilities, are given in the accompanying table :

Frequency (Mc./s.) Wave-length (cm.)	D.C.	2300 13	2600 11·5	3000 10	3400 8·8
Iron, bright	101	50	65	63	61
Iron, white annealed	140	41	60	67	65
Steel, bright	65	38	34	39	25
Steel, white annealed	102	31	31	28	28
Nickel	13	7	8	10	8

The probable error in these results is of the order of 10 per cent.

The measurements are now being extended to other frequencies and ferromagnetic materials. A fuller account of these measurements, together with their bearing on the theoretical considerations advanced by Becker[5] and Kittel[6], will be published in due course.

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Decay of Luminescence due to Forbidden Optical Transitions

IT is well known that the exponential, temperature-independent decay of luminescence in solids such as sulphides and silicates of zinc and ruby is characteristic of forbidden optical transitions within the specific luminescence emission centres, and the mean life-time of such decays can be of the order of milliseconds in these materials[1,2]. The nature of these transitions in the chromium centres of ruby has been thoroughly studied by Thosar[3], and the resulting decay of luminescence by Garlick and Wilkins[2]. In 1943, Dr. A. F. Wells, working in this laboratory, found that manganese centres in certain fluoride crystal lattices produced such decays with time constants of the order of 10 sec.$^{-1}$, that is, the mean decay time being 100 msec.

We have recently studied the function of rare earth impurity in some silicate phosphors, and find that the emission centres formed by inclusion of europium ions in strontium silicate give rise to an exponential decay of luminescence which is independent of temperature (experimental range 90°–600° K.) and has a mean life-time of 2·3 sec., this decay being preceded by a faster component of very short life-time. Both components appear for excitation by 3650 A. and by 2537 A., but in addition the shorter wave-length produces a long-duration exponential decay of phosphorescence which is strongly dependent on temperature and is associated with a thermoluminescence characteristic of a single depth of electron trap of 0·75 eV. as derived from the relations developed by Randall and Wilkins[4]. Excitation by the short wave-length also causes photoconduction, but this is not closely associated with the luminescence processes in the material. Under all wave-lengths of excitation the emission spectrum consists of a broad band in the visible region with maximum in the green, and does not compare with the usual spectra of salts and solutions of salts of europium[5].

So far, studies have been of a preliminary nature and little is known of the location of the europium ion in the silicate lattice. The studies of electron trapping show that the traps are specific to the centres and may be either within each centre or very near it. The efficiency of the luminescence is about 0·1 of that for a willemite phosphor excited by the short wave-length of 2537 A.

We have found such low transition probabilities in dye molecules when adsorbed on to solid surfaces after the method of Travniček[6], the mean life-times being of the order of 1·6 sec. for such molecules as carbazol, æsculin and phenanthrene. Such decay processes may also be followed by a temperature-dependent decay of longer duration.

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Bond-Strengths of Methyl-Iodine and Methyl-Magnesium

THE heats of the following reactions in ether solution have been determined calorimetrically :

$$CH_3 - MgI + I_2 = CH_3I + MgI_2 - 45{\cdot}4 \pm 1{\cdot}0 \text{ kcal.}$$

$$2CH_3{-}Mg{-}I + I_2 = \underset{\text{(gas)}}{C_2H_6} + 2MgI_2 - 103{\cdot}4 \pm 3 \text{ kcal.}$$

Using these values, and published data[1] for the heats of atomization of solid iodine, for the bond-strength $D(CH_3-CH_3)$ and for the latent heats of volatilization of ethyl ether and methyl iodide, the bond-strength is calculated

$$D(CH_3 - I) = 54{\cdot}75 \pm 1{\cdot}4 \text{ kcal.},$$

in good agreement with the value of 54 kcal. obtained from kinetic data[2].

A (less reliable) value of the bond-strength

$$D(CH_3 - Mg) = 67{\cdot}0 \text{ kcal.}$$

can also be computed from the calorimetric data.

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DIFFRACTION OF X-RAYS BY THE ALLOY $AuCu_3$

THE alloy $AuCu_3$ has an ordered structure below 391° C. If a disordered alloy is heat-treated below this temperature, superlattice lines appear on X-ray powder photographs, and the development of the perfectly ordered structure can be followed by observation of these superlattice lines; they are diffuse at first and increase in sharpness as the heat-treatment progresses, until they become as sharp as the main lines.

A simple explanation of this phenomenon is that the domains of similar order (anti-phase domains) are initially much smaller than the crystal grains in which they exist; on this basis, Jones and Sykes[1] showed that it should be possible to derive the sizes of the anti-phase domains from the breadths of the superlattice lines. Detailed investigation showed, however, that different lines gave different results, and the problem remained unsolved.

Wilson[2] has produced a method of calculating the diffraction effects given by such an alloy, and has shown that the breadths of the various superlattice lines will be dependent upon the way in which one domain is bounded by its neighbours; he tried the effect of imposing certain conditions on the boundaries and found one model that gave fair agreement with Jones and Sykes' results. He pointed out, however, that it was possible that other models may give as good agreement or even better.

We have attempted to test Wilson's theory by taking X-ray oscillation photographs of a single crystal; such photographs contain much more evidence than powder photographs and so should provide a much more stringent test of the theory. Similar considerations have led Strijk and MacGillavry[3] also to carry out experimental work on a single crystal to test a theory of their own[4]. Their theory is rather different from Wilson's, and their experimental results do not fit in perfectly with either. We believe, however, that their experimental methods are not well suited to differentiate between the two theories, as the following considerations show. MacGillavry and Strijk's theory would lead to sharp reciprocal points for the main reflexions and diffuse spots all of the same shape and with cubic symmetry for the superlattice reflexions; Wilson's theory leads to a more complicated representation which is shown in Fig. 1. MacGillavry and Strijk used a rod-like crystal with its length approximately in the [110] direction, and they investigated the distribution of intensity only in the plane perpendicular to [110]. Therefore, they have not checked that the spots have cubic symmetry, as their theory demands; nor have they disproved Wilson's theory, since this leads to similar shapes for all spots with $h + k = 0$.

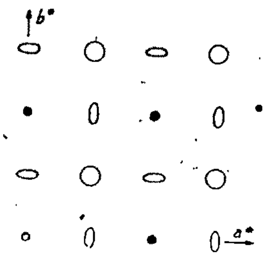
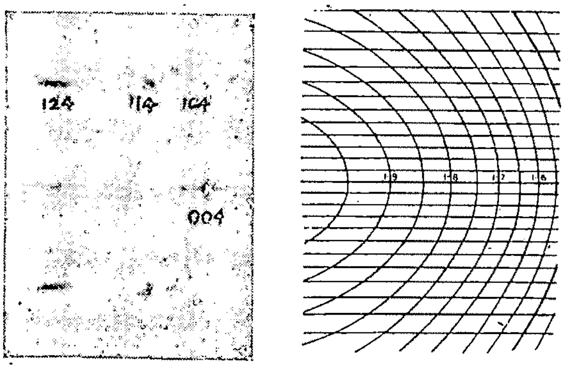


Fig. 1. RECIPROCAL LATTICE OF $AuCu_3$ ACCORDING TO WILSON'S THEORY



a b

Fig. 2 a and b. PORTION OF OSCILLATION PHOTOGRAPH OF $AuCu_3$ AND CORRESPONDING PORTION OF BERNAL CHART

Our crystal is smaller than that used by MacGillavry and Strijk; it gives main reflexions that are quite small, and so the shapes of the superlattice reflexions stand out clearly. Preliminary results show qualitative agreement with Wilson's theory; this is shown by Fig. 2, which is part of an oscillation photograph about the [100] axis.

It will be seen that the spots are not all of the same shape; for example, 114 is elongated at an angle to the layer line and 124 is elongated along the layer line. Such an effect cannot be produced by differences in the geometrical conditions for reflexion due to difference in θ. Moreover, the slope of the spot 114 is about the same as that of the curves on the Bernal chart (Fig. 2b) at the same point, which means that the elongation is parallel to one of the reciprocal axes. In this respect, the results are in accordance with the reciprocal lattice shown in Fig. 1.

Oscillation photographs do not provide a complete test, as the spots recorded represent projections of the reciprocal-lattice spots on to a plane. We are, therefore, undertaking a more detailed investigation of sections of the spots, and this should provide quantitative evidence by means of which the two theories can be adequately tested.

I. G. EDMUNDS
R. M. HINDE
H. LIPSON

Physics Department,
College of Technology,
Manchester.
April 15.

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[1] Jones and Sykes, *Proc. Roy. Soc.*, A, **166**, 376 (1938).
[2] Wilson, *Proc. Roy. Soc.*, A, **181**, 360 (1943).
[3] Strijk and MacGillavry, *Physica*, **12**, 129 (1946).
[4] MacGillavry and Strijk, *Physica*, **11**, 369 (1946).

IN treating the integral breadths of the lines in the powder photographs of $AuCu_3$ obtained by Jones and Sykes[1], it was not necessary to consider the actual shapes of the regions of high intensity in the reciprocal lattice, the apparent particle-size of the *hkl* reflexion being given directly by

$$\varepsilon = (J_0 V_0)^{-1} \int V_t J_t dt, \qquad (1)$$

where V_t is the volume common to the crystal and its 'ghost' shifted a distance t in the *hkl* direction, and J_t is the mean value of the product FF^* for two cells separated by a distance t in the *hkl* direction[2]. The distribution of intensity in the reciprocal lattice may be obtained from the same functions. If a, b, c

are the cell edges, U is the volume of the unit cell, $V(x, y, z)$ and $J(x, y, z)$ are the values of V and J corresponding to the displacement xa, yb, zc, and ua^*, vb^*, wc^* are distances measured from the point hkl of the reciprocal lattice, the intensity of reflexion is proportional to

$$H(u,v,w) = U^{-1}\iiint V(x,y,z)\, J(x,y,z) \exp\{2\pi i\,(ux+vy+wz)\}\, dx dy dz. \quad (2)$$

This expression was derived in connexion with line broadening in hexagonal cobalt[3], where, however, it was written in the form of a summation. In many cases the variation of V_t or $V(x,y,z)$ can be neglected in comparison with the more rapid variation in J_t or $J(x,y,z)$.

Equation 2 can be evaluated for several of the models suggested[2] for the occurrence of mistakes in $AuCu_3$. For the fifth model, in which gold atoms avoid one another, it gives[4]

$$H(u,v,w) = N(\text{Au-Cu})^2 \cdot \frac{\alpha}{\alpha^2+\pi^2u^2} \cdot \frac{\alpha}{\alpha^2+\pi^2v^2} \cdot F(w) \quad (3)$$

for the superlattice reflexions having h and k both odd or both even; if k and l or l and h are both odd or both even, the variables u,v,w are appropriately permuted. The factor $F(w)$ is the 'normal' variation of intensity in the reciprocal lattice, being practically zero for w differing appreciably from zero, and α is the probability of a mistake in a distance a. This leads to the type of reciprocal lattice pictured by Edmunds, Hinde and Lipson[5]. For the sixth model, which is similar except that the gold atoms merely tend to avoid one another, the integrations necessary to evaluate Equation 2 cannot be easily performed, but qualitatively the effect will be to give the disks a finite thickness, the relative amount of the thickening depending on the ratio of the probability α of a mistake in which gold atoms avoid one another to the probability γ of a mistake in which they do not.

This model thus accounts qualitatively for the results of Strijk and MacGillavry[6] and of Edmunds, Hinde and Lipson. It is possible to make a semi-quantitative comparison with the former, since they use their experimental data to evaluate the function $J(x,y,z)$, or rather the section of it by the plane $y+z = 0$, for reflexions of the type $hk\bar{k}$. The theoretical value of J for these reflexions is[3]

$$J(x,y,z) = (\text{Au-Cu})^2 \exp\{-2\alpha(|y|+|z|) - 4\gamma r/3\}, \quad (4)$$

where $r^2 = x^2 + y^2 + z^2$. In polar co-ordinates in the section evaluated

$$J(r,\theta) = (\text{Au-Cu})^2 \exp\{-(2\sqrt{2}\alpha\,|\sin\theta\,| + 4\gamma/3)r\}, \quad (5)$$

which may be compared with the contours given in Strijk and MacGillavry's Fig. 7. Equation 5 suggests that the contours of constant J will all be of the same shape, given by

$$r^{-1} = 4\gamma/3 + 2\sqrt{2}\alpha\,|\sin\theta\,|, \quad (6)$$

and that their sizes will be proportional to log J. The contours obtained by Strijk and MacGillavry, normalized to $r = 1$ for $\theta = 45°$, lie within the area shaded in Fig. 1, so that there is little variation in shape. The full line is the curve given by Equation 6, the values of α and γ obtained from Jones and Sykes' powder photographs being used. The agreement is fair, being about as good as that obtained experimentally for different reflexions. In Fig. 2 log J is plotted against the actual radii for $\theta = 45°$. A straight line can be drawn through the points for the smaller values of J, those for the larger lying below it. Strijk and MacGillavry give reasons for supposing that the larger values of J are too low, so that their experiments are not inconsistent with the model proposed to explain the powder photographs of Jones and Sykes.

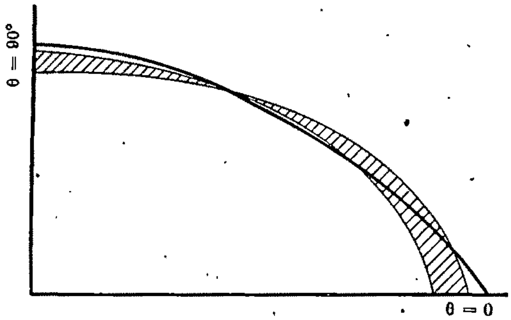

Fig. 1. SHAPES OF EXPERIMENTAL (SHADED AREA) AND CALCULATED (FULL LINE) CURVES OF CONSTANT J

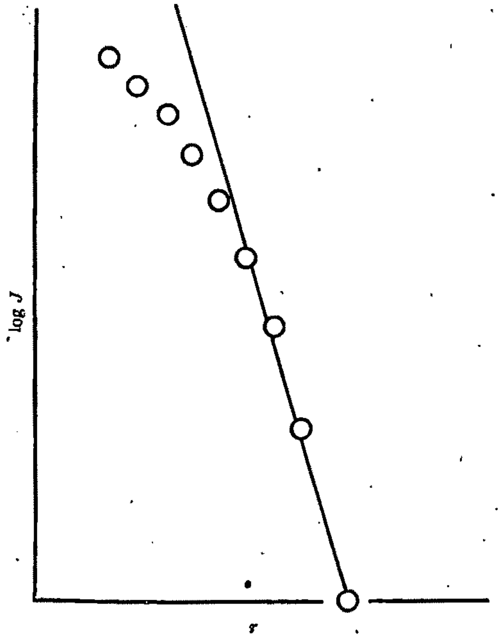

Fig. 2. EXPERIMENTAL (CIRCLES) AND CALCULATED (FULL LINE) MODE OF VARIATION OF LOG J WITH r

Further work is necessary, however, to establish the correctness or otherwise of this model. It is somewhat difficult to imagine the internal state of a crystal containing mistakes both on 100 planes, such that gold atoms do not come into contact, and on random planes, with no avoidance by the gold atoms. It may be necessary to modify the assumption that the probability of a mistake in any interval is independent of the position of other mistakes.

A. J. C. WILSON

University College,
Cardiff.
April 18.

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[1] Jones F. W., and Sykes, C., *Proc. Roy. Soc.*, A, **166**, 376 (1938).

[2] Wilson, A. J. C., *Proc. Roy. Soc.*, A, **181**, 360 (1943).

[3] Wilson, A. J. C., *Proc. Roy. Soc.*, A, **180**, 277 (1942).

[4] Wilson, A. J. C., "X-Ray Optics" (London: Methuen and Co., in course of publication).

[5] Edmunds, I. G., Hinde, R. M., and Lipson, H., preceding communication.

[6] Strijk, B., and MacGillavry, C. H., *Physica*, **12**, 129 (1946).

ELECTRODE PROCESSES

On April 9 and 10 a discussion on "Electrode Processes" arranged by the Faraday Society was held at Manchester. The meeting was attended by nearly two hundred people, including several distinguished overseas visitors.

Faraday Society discussions have often marked an important stage in the development of branches of physical chemistry, and it was at a very timely moment in the development of the subject of electrode processes for such a discussion to take place. It seems to be probable that the most important advance in experimental physical chemistry in the next decade will lie in the application to the science of the techniques of electronic engineering, developed particularly during the War, and the field of electrode processes may be one which will yield readily to attack by the new weapons; in fact, a most promising start has already been made. For this reason, a review of the subject at this stage will undoubtedly give great impetus to development along the more important lines.

Altogether, forty papers were presented at the meeting, and they were discussed in groups under the headings "General", "Hydrogen Overvoltage", "Deposition of Metals", "Oxygen Overvoltage" and "General Anodic Processes and Cell Reactions". An introduction to the whole discussion was given by Prof. W. F. K. Wynne-Jones (Dundee), and the various sections were introduced by Prof. Wynne-Jones, Dr. A. Hickling (Liverpool) and A. W. Hothersall (Woolwich). The president, Prof. W. E. Garner (Bristol), was in the chair throughout the meeting.

The subject of hydrogen overvoltage was taken first, and at this stage Prof. A. L. Ferguson (Ann Arbor) directed attention in his paper to the many unsolved fundamental problems associated with the interface between electrode and electrolyte, and to the difficulties in interpreting data obtained by different methods.

A communication by Prof. A. Frumkin (Moscow) discussed the mechanism of hydrogen discharge on the basis of extensive experimental work. The data are interpreted as proving that the discharge of hydrogen ions is the slowest stage in the evolution of hydrogen from acid solutions on mercury, but that subsequent stages, for example, the combination of hydrogen atoms to form molecules, may assume importance with low overvoltage cathodes. The slow-discharge theory was the basis of a theoretical contribution by Dr. J. Weiss (Newcastle-on-Tyne), in which the discharge was considered as the transfer of a proton from the hydrated to the surface-adsorbed state. In a lively discussion the slow-discharge theory was strongly criticized by some speakers, one of the points raised being the apparent absence of a satisfactory relation between the work function of the metal and the value of the overvoltage. The chief alternative theory is the slow combination of hydrogen atoms at the cathode. It was regrettable that Prof. Frumkin was unable to be present in order to contribute to the discussion on this controversial issue. Prof. Garner suggested that a compromise between the two theories would probably be more satisfactory than either of them taken by itself.

J. N. Agar (Cambridge) suggested an analysis of overvoltage data in the manner adopted for rate constants, deriving a 'heat of activation' and an 'entropy of activation', as an examination of these parameters might throw some light on the possible discharge mechanism.

Dr. F. P. Bowden (Cambridge) and K. E. W. Grew (Cambridge) presented data on overpotential measurements at very low current densities on mercury which demonstrate that Tafel's equation, whatever its general validity, is in any event closely obeyed by mercury cathodes over the current density range 10^{-10}–10^{-2} amp./cm.^{2}. The same authors re-investigated the capacity of the double layer on mercury in sulphuric acid solution by the charging-time method. Their value (20 μf./cm.^{2}) is in close agreement with measurements by different procedures, but considerably higher than previous values obtained by the same method. It was pointed out in the discussion that, in spite of the agreement between different determinations, the uncertainty in the value of this quantity is still considerable, for example, a value of 12 μf./cm.^{2} was preferred by Dr. Hickling.

The behaviour of palladium electrodes during the discharge of hydrogen was the subject of a paper by H. P. Stout (Saltcoats). P. M. Bryant (Bristol) and G. E. Coates (Bristol) described an investigation of the polarization of platinized platinum electrodes, where an ageing effect of the electrodes was discovered. Periodic changes in the behaviour of anodically polarized platinum electrodes were discussed by Dr. J. A. V. Butler (London) and G. Armstrong.

In the group of "General" papers the subject of diffusion at the electrodes, of importance in the theory of concentration polarization, was treated mathematically by J. N. Agar and by B. Levich (Moscow). The kinetics of rapid electrode reactions have been studied experimentally by J. E. B. Randles (Birmingham), the analysis of the results leading to values for rate constants of electrode reactions.

In an important theoretical contribution, T. B. Grimley (Bristol) and Prof. N. F. Mott (Bristol) calculated from first principles the potential difference at the interface between a solid and an ionic solution, the example chosen being that of the silver–silver bromide electrode.

There were several papers on the cathodic deposition of metals. The relation between the structure of the deposit and the conditions of deposition was examined by electron diffraction experiments by Prof. G. I. Finch (London), H. Wilman (London) and L. Yang (London). Two communications by T. P. Hoar and J. N. Agar dealt with the theoretical analysis of electrical conditions in plating baths. Polarization in the electrodeposition of metals was discussed by G. E. Gardam (London), who showed that the physical form of the cathode metal deposit may influence the polarization, the cause being the difficulties of disposing of the new atoms in the grain lattice.

The mechanism of cathodic metal deposition was investigated by Prof. J. Heyrovský (Prague), using a new modification of the polarographic technique by which electrodeposition involving an irreversible discharge may be recognized. The results show that all one-electron discharges are reversible, but that most processes with more than one electron transfer are irreversible; and it is deduced that the electrons are transferred successively.

The first paper on the subject of anode processes was contributed by Dr. A. Hickling, who directed attention to anomalies observed in some anodic reactions; for example, the Kolbe reaction, where processes occur at a high positive potential in preference to other possible reactions requiring a lower potential. There was considerable discussion on this, the question being whether the phenomenon could be explained by some specific adsorption mechanism, or whether a more fundamental electrochemical problem was raised by it.

A number of contributions dealt with determinations of oxygen overvoltage. A considerable degree of reproducibility has been achieved in some of the studies (± 0·01 to ± 0·03 V.), but agreement between different laboratories is not yet satisfactory. It was urged earlier in the discussion by Sir Charles Goodeve that in overvoltage measurements more attention should be given to the influence of the procedure of measurement on the results. The effect on the oxygen overvoltage of electrode material current density and time for aqueous solutions was examined by Dr. A. Hickling and S. Hill, and that of solvent variation (also on hydrogen overvoltage) by Dr. J. O'M. Bockris (London).

The last group of papers was devoted to other anodic processes and cell reactions in general, several communications dealing with anodic polarization of metal electrodes by surface oxides. M. Haïssinsky (Paris) pointed out that hydrogen peroxide oxidations may lead to chemically different products from anodic oxidations, which does not agree with the general theory of intermediate hydrogen peroxide formation in anodic oxidations.

An interesting contribution by Prof. H. J. C. Tendeloo (Wageningen) showed that electrode potentials are not only of applied but also of direct interest to biologists, and presented data about the application of electrochemical theory to calculate the potentials of plant roots.

A brief summary of this kind cannot, of course, lay claim to either completeness or even impartiality in the selection of the points reported in it; but the complete proceedings of the meeting, including the papers read and remarks made in discussion, will be published in the *Transactions of the Faraday Society* as Volume 43 A (1947). V. GOLD

MILK, TINNED FOODS AND BREAD

AT the Health Congress of the Royal Sanitary Institute recently held at Torquay, Section E (Food and Nutrition) met jointly on June 6 with the Food Group of the Society of Chemical Industry. Three papers were given at this session, each dealing with an important and topical aspect of food in relation to health. Prof. H. D. Kay (president of the Section) directed the attention of the meeting to the slow decline, that began some years before the War and was acutely accentuated during the winter months of the war years, in the compositional quality, and therefore in the nutritional value to the consumer, of market milk. The only reason for the existence of the milk industry is the fact that cows' milk is a valuable human foodstuff. Anything, therefore, causing a decrease in its nutritional value is of major importance not only to the consumer but also to all engaged in the industry, whether producers or distributors.

The insidious but now well-established decline which began to declare itself some years before the War is a diminution both in the fat and the non-fatty solids content of milk (when figures are averaged over the year). This amounts to an increase in its water content; but it is not due to adventitious watering—experimental surveys have shown that there are few indeed of the farmers of Great Britain who are guilty of extending the volume of the milk in this way. The main cause of this slow decline is the increased use, in breeding, of what Prof. Kay called 'watery' bulls, that is, bulls selected merely on account of the high milk yields of their female relatives, without regard for the *quality* of the milk. 'Watery' bulls of both the Friesian and the Shorthorn breeds are involved; the rapid increase in recent years in the number of relatively poor-quality Friesian bulls is well known.

As regards the acute fall in non-fatty solids to well below the 'legal' presumptive limit of 8·5 per cent, a fall which occurred during the late winter months (January to April) in very many herds during the War years and since, and which reached in April 1947, in some districts, the lowest figures yet recorded, it has been conclusively demonstrated by experiments at the National Institute for Research in Dairying during the past two years that the main cause is a deficiency of winter feeding-stuffs. It is in the valuable proteins of the milk that this compositional defect is most apparent, and not in the fatty portion. An unexpected finding is that shortage of energy (calories or 'starch equivalent') in the cows' diet is more serious in its effects in diminishing the milk protein than is shortage of protein, provided the diet contains sufficient energy. The level of non-fatty solids in the milk returns to normal, or even goes above normal, within a few days of the cows going out to grass in the spring.

Prof. Kay suggested that the quickest and most satisfactory way of reversing the slow decline in average milk quality would be to pay milk producers on the basis of compositional quality and not, as at present, merely on volume. The suggested method of payment, which is already applied in several countries abroad and presents no insuperable difficulties, would reimburse the dairy farmer for making those changes in breeding and management of his herd which would, if persisted in over a few years, achieve again the higher milk quality so desirable from the point of view of human nutrition. The acute fall in *winter* milk quality, which even to-day does not occur in adequately fed, well-managed herds, can only be dealt with by an improvement in the supply of winter feeding-stuffs. Even if more high-energy concentrates can be imported—and Prof. Kay thinks that every endeavour should be made to increase such imports—it will also be necessary to improve the quality and quantity of home-produced fodders for winter consumption, such as high-quality hay, silage made from young grass or from cereal-legume mixtures, kale, kale silage, dried grass, etc. A great deal can still be done in this direction on a very large number of dairy farms.

Mr. Stewart Swift (Oxford) spoke of the increasing anxiety with which public health and sanitary authorities are viewing the steady decline in milk quality; it concerns them not only from the point of view of human nutrition but also on legal grounds. He hoped that no time would be lost in applying the lessons derived from the surveys and the experimental work. Principal A. W. Ling (Seale Hayne) mentioned work carried out under his direction in the Bristol Province on the relation between low-quality hay and the decrease in the compositional quality of milk; but emphasized the very serious difficulties under which the present-day dairy farmer is labouring.

The present state of our knowledge regarding certain major microbiological problems of the food canning industry was discussed by Mr. T. E. Bashford (London). The ideal heat process for any given canned food is one which, while of sufficient duration and temperature to render the product 'commercially sterile', yet has a minimal effect on its quality, nutritional value and on the attractiveness of its flavour. 'Commercial sterility' does not mean absolute sterility, since the finished pack may contain viable spores of thermophilic bacteria which do not give rise to difficulties so long as the cans are marketed under ordinary conditions of climate. Two main factors determine the adequacy of a process, namely, the rate of penetration of heat into the least accessible part of the contents of the can, and the thermal death-time of the most resistant of the organisms capable of causing spoilage or danger to health. The thermal death-time curve for *Cl. botulinum*, the most heat-resistant and dangerous of the food-poisoning organisms, has been very carefully determined, and in practice it has been found normally satisfactory if the heat exposure, determined as regards temperature by that reached in the slowest-heating portion of the can, has a 'lethal value' about three times that needed to destroy *Cl. botulinum*. In some cases, particularly where the pack has to go to tropical or semi-tropical countries, six to seven times the minimal lethal conditions for *botulinum* are used.

Mr. Bashford described how 'lethal rates' and 'lethal values' are determined, and showed how accurate determination of temperatures, at any part of a can during processing, can be carried out by means of thermocouples inserted into the pack before autoclaving. He also dealt with post-processing infection of the can contents through minute holes which are sometimes left, particularly if the dimensions of cover and body do not conform to quite close mechanical tolerances, when the cans are being sealed. Organisms from the cooling water or from the air may be drawn through the defective seams as the internal pressure of the can falls during cooling. As a precautionary measure, chlorination of the cooling water is now extensively used in canneries, with marked reduction in the proportion of cans that become 'blown'. The importance was stressed of the highest possible degree of microbiological cleanliness, not only in the food and other raw materials, such as sugar, before canning, but also in the whole of the canning plant.

The realization by progressive millers and bakers of the same need for microbiological cleanliness was mentioned by Dr. E. C. Barton-Wright, who gave an interesting account of some microbiological aspects of flour-milling and baking. Beginning with the quorn, which was a type of property having a very special legal position in ancient society, Dr. Barton-Wright spoke of the evolution of power-driven mill stones and then of the sudden change, some seventy years ago, to the equivalent but fundamentally very dissimilar machinery which, with further modifications, carries out the modern, complicated process of flour milling. The all-important factor in the prevention of microbiological spoilage of wheat or flour is the moisture content, and experimental work in this field was described in some detail. Whereas wheat can be stored for long periods with complete safety at moisture content less than 16 per cent, with flour the conditions are more complex. Though moulds do not grow in flour which has a moisture content of less than 16 per cent, they nevertheless remain metabolically active when the moisture content is between 16 and 14 per cent, and will attack first the saturated acids and later the unsaturated fatty acids in the fat or oil naturally present in the flour, with disastrous results as regards baking quality and flavour. The metabolic activity of the moulds ceases below about 14 per cent moisture, but there is a danger of oxidative rancidity setting in if the moisture content is too far reduced, particularly in high-extraction flours. It is better, therefore, to store flour at a moisture content between 11 and 12 per cent, when the keeping life of a strong white flour under reasonably cool conditions may be as long as ten years. Even high-extraction flours, for example, National flour of 85 per cent extraction, will keep its quality under these conditions for several months.

Dr. Barton-Wright discussed the conditions controlling the growth of moulds on and in baked loaves. Mould infection is almost always external, and simple precautions in the bakehouse, the delivery van and the home should prevent it. The methods of prevention of the troublesome bacterial disease of bread known as 'rope', usually caused by *B. subtilis* spores in the flour which are not destroyed by the baking process, was described. More acid conditions during baking tend to prevent, and less acid conditions to foster, an outbreak of 'rope'.

A lively discussion followed, in which Mr. C. Ash (Coventry), Dr. J. Sword (Glasgow), Mr. D. H. F. Clayson (London), Mr. Hooper (Bristol) and others took part. It ranged over the effect of mastitis on milk quality, the alleged maldistribution of feeding stuffs for milk production, the absence of 'rope' in Scotland as a result of the more acid doughs used there, and the occasional presence in canned and preserved food of heat-stable toxins of bacterial origin.

WAR-TIME DEVELOPMENTS IN METALS AND ALLOYS

THE tenth Edward Williams lecture to the Institute of British Foundrymen was given by Sir Edward Appleton on "New Metals for Old". After a general discussion of the metallic state, Sir Edward discussed a number of aspects of metallurgy on which new light had been thrown in recent years.

The development of materials for war purposes has led to the introduction of new alloys, of which a steel containing carbon 0·4 per cent, nickel 13·5 per cent, chromium 13·5 per cent, tungsten 2·5 per cent, molybdenum 1·8 per cent, cobalt 10·5 per cent, niobium 3·4 per cent, may be mentioned as typical. This steel, developed for high-temperature services in the gas turbine, has a creep-rate of 0·2 per cent in 100 hours under a load of 5 tons per square inch at 800° C. Improvements in the nickel–chromium alloys have been effected by the addition of titanium, which brings about a dispersion of particles of titanium carbide. Nichrome is also improved from the point of view of creep resistance by the precipitation of a complex intermetallic compound of nickel, titanium and aluminium.

An iron–nickel alloy with 36 per cent of nickel and 5–8 per cent of chromium, together with a certain amount of titanium; has been developed where low thermal expansion, as, for example, in a tuning fork, is required. The magnetic properties of iron–silicon alloys used in transformers, etc., have been shown to be effected by the crystalline orientation of the grains. Better magnetic properties are found in a direction parallel to the edges of the cube than in any other, and a technique has been worked out to ensure that this orientation is, at any rate, largely obtained.

Another example of the development in magnetically soft material are the 'dust-cores' used in transformers and inductances for telecommunication work. Here, a constant permeability is desired. A reduction in the size of the particles greatly reduces the effective permeability, but stabilizes its value for different magnetic fields as well as reducing the loss due to eddy currents. A carbonyl iron in the form of spherical particles a few thousandths of a millimetre in diameter has been produced in Great Britain for the purpose.

Passing on to the magnetically hard materials, the enormous advances which have been made in this field were outlined; the value with some alloys of applying during the cooling a magnetic field which produces a large increase in the remanence in the direction of the applied field was pointed out. Here, as in the case of the anisotropic silicon-iron, it is important that the design should be such that the material is used in the favourable direction only.

In conclusion, what may be an extremely important development in cast iron was mentioned. This, in brief, is the treatment of the iron in such a way that the graphite formed is of the nodular type characteristic of black-heart malleable iron, which hitherto has only been possible after lengthy heat-treatment. F. C. T.

THE *ZOOLOGICAL RECORD*

THE appearance of volume 81 of the *Zoological Record*, dealing mainly with the literature of 1944, is worthy of special notice, for this comprehensive bibliography of zoological literature has been published regularly since its foundation in 1864. The *Record* is still mainly dependent on donations for its production, and until the Zoological Society of London assumed responsibility for its publication it underwent many changes in its direction which might have had a disastrous effect on a less hardy annual.

The object of the *Record* is to give a reference to every article or book of zoological importance throughout the world that has appeared in the previous year. During the War it was impossible to bring out the volumes to time, and at the moment there is a delay of nearly two years; but as soon as printing conditions are easier it is hoped to get back to the normal practice of completing the *Record* in the year following the literature to which it refers. The cost of producing such a work is, of course, far beyond the price at which it is sold, and it could scarcely hope to be self-supporting; but a further measure of support might be expected from professional zoologists, some of whom seem to be unaware of its existence. The complete volume, published at £4 (subscription rate £3 5s.), is more suitable for libraries, university departments, etc.; but the sections are issued separately as soon as they are ready, and since their cost ranges from only 2*s*., in the case of the smaller groups, to 6*s*. for Aves, and a maximum of 15*s*. for Insecta, it should be possible for any zoologist to provide himself with the literature of the group in which he is specially concerned.

There is a mistaken impression that the *Zoological Record* is only of interest to the systematist, but it is also invaluable to the comparative anatomist, the embryologist and the field naturalist; and publications concerned in a general way with genetics, ecology, and other branches of zoology are also included.

Each reference is allotted to one of the twenty odd sections into which the *Record* is divided, and then dealt with under three headings: (1) Titles, containing complete references to all articles arranged in alphabetical order of the authors' names; (2) Subject Index, giving a detailed analysis of the subjects dealt with in each article; and (3) Systematic Index, comprising a list of all the animals referred to in the section concerned, including those described as new forms, arranged in systematic order. This arrangement enables the reader to find the information regarding the current zoological literature of any group under the authors' names, under specific subjects, or under the scientific names of animals.

The nature of the service provided by the *Zoological Record* is illustrated in the following excerpt:

I. TITLES.
  66.—CHRISTENSEN, J. F. The oocysts of coccidia from domestic cattle in Alabama (U.S.A.), with descriptions of two new species. *J. Parasit.* Urbana, **27**, 1941, pp. 203–220. 2 pls. 1 text fig.
II. SUBJECT INDEX.
  STRUCTURE.
    SPOROZOA.
      Eimeria spp. (including new) from American cattle, CHRISTENSEN, **66**.
  ECOLOGY.
    PARASITISM: Hosts—
      MAMMALIA: *Bos taurus*, intestine (U.S.A.): *Eimeria alabamensis* spp.n., *E. subspherica* spp.n. (Sporoz. Coccid.). CHRISTENSEN, **66**.
  ECONOMICS.
    COCCIDIOSIS: Coccidiosis in U.S.A. cattle. CHRISTENSEN, **66**.
III. SYSTEMATIC INDEX.
  4. SPOROZOA. (b) COCCIDIIDA.
    Eimeria alabamensis, *E. subspherica* spp.n. (with key to other spp.) from cattle, U.S.A. CHRISTENSEN, **66**.

It should be emphasized that donations to the *Zoological Record* are still quite inadequate, and further support is urgently required from institutions and individuals. EDWARD HINDLE

FORTHCOMING EVENTS

Tuesday, September 2—Tuesday, September 9

WORLD POWER CONFERENCE (at The Hague, Holland).—Conference on "Fuel Economy".

Friday, September 5

INSTITUTE OF ECONOMIC ENGINEERING (at Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Colonel Bernard Ungerson: "Personnel Selection: Army Experience in its relation to the Problems of Industry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER-IN-CHARGE, CHEMISTRY DEPARTMENT, in the Technical Education Branch of the Department of Public Instruction, Sydney—The Official Secretary, New South Wales Government Offices, 56–57 Strand, London, W.C.2 (September 5).

LECTURER IN PHYSICS—The Secretary, University Offices, 38 North Bailey, Durham (September 6).

ASSISTANT LECTURER IN PHYSICAL GEOGRAPHY, and an ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College of Wales, Aberystwyth (September 6).

LECTURER IN CHEMISTRY, and a LECTURER IN PHYSIOLOGY—The Principal, Central Technical College, Suffolk Street, Birmingham (September 6).

Assistant Lecturer in Physics in the Bradford Technical College—The Director of Education, Town Hall, Bradford (September 6).

Chair of Comparative Philology at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 10).

Chair of Civil Engineering in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 12).

Senior Biochemist at the Teaching and Research Laboratory in the Maudsley Hospital Post-Graduate Medical School—Prof. S. Nevin, Training and Research Laboratory, Maudsley Hospital, Denmark Hill, London, S.E.5 (September 13).

Lecturer in Natural Philosophy in University College, Dundee—The Secretary, The University, St. Andrews (September 13).

Assistant Lecturer in Agricultural Zoology—The Registrar, The University, Leeds 2 (September 15).

Research Fellowship in Medical Physics, and a Lecturer in Town and Country Planning—The Registrar, King's College, Newcastle-upon-Tyne (September 15).

Senior Economist—The Secretary, Agricultural Economics Research Institute, Parks Road, Oxford (September 15).

Lecturer in Geography in the University of Ceylon—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 20).

Professor of Anatomy, a Professor of Biochemistry, a Professor of Bacteriology, a Professor of Parasitology, a Professor of Pathology, and a Professor of Social Medicine and Hygiene, in the King Edward VII College of Medicine, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 20).

Science Graduates with qualifications in Geology and/or Physics, especially Geophysics, for the New Zealand Geological Survey—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 20).

Principal Lecturers, Senior Lecturers, and Lecturers, in Ballistics, Mechanics, Machines, Materials and Structures, Heat Engines, Electrical Engineering, at the Military College of Science, Shrivenham, Wilts—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1965 (September 25).

Research Assistant in the Biochemical Department, and a Statistician to assist in the design of nutritional experiments and undertake analysis of the resulting data—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (September 25).

Safety Officer at the Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting D.239/47A (September 27).

Assistant Electrical Engineer at the Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting D.240/47A (September 27).

Chair of Veterinary Science in the University of Ceylon—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 30).

Lecturer in Mathematics at the University of Tasmania—The Agent-General for Tasmania, Golden Cross House, Charing Cross, London, W.C.2 (September 30).

Senior Lecturer in Structural Engineering at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 30).

Chemists (men and women) of Degree standard for temporary posts in the grades of Senior Scientific Officer, Scientific Officer, Senior Experimental Officer, and Experimental Officer, in the Chemical Inspection Department, Ministry of Supply, for service in North-West England—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.694/47A. (September 30).

Director of Radio Research in an enlarged Radio Research Organisation to be established by the Department of Scientific and Industrial Research in extension of its present work in the Radio Division of the National Physical Laboratory and elsewhere—The Secretary, Civil Service Commission, Scientific Adviser's Branch, 27 Grosvenor Square, London, W.1, quoting No. 1967 (September 30).

Lecturer (Grade IIc) in Chemical Engineering, a Research Fellow for fundamental work on the oxidation and constitution of coal, and a Research Scholar for fundamental work on the oxidation and constitution of coal—The Secretary, The University, Edmund Street, Birmingham 3 (October 1).

Regius Professor of Materia Medica and Therapeutics at the University of Glasgow—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (October 8).

Chair of Chemical Pathology, Senior Assistants (one in Bacteriology and one in Pathology), and a Senior Lecturer in Pathology, in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 14).

Professor of Philosophy—The Secretary and Registrar, University College of North Wales, Bangor (October 31).

Senior Lecturer in Horticulture in Canterbury Agricultural College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 31).

Lecturer in Statistics and Economics at the University of Tasmania—The Agent-General for Tasmania, Golden Cross House, Charing Cross, London, W.C.2 (October 31).

Junior Lecturer in Zoology, and a Technician in the Department of Zoology, at the Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 31).

Medical Graduates for (*a*) research on the pathology of schistosomiasis in man and experimental animals (mainly abroad), and (*b*) the clinical care of patients at the Field Research Station, Gambia, to undertake nutritional and other investigations—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

Senior Laboratory Steward for chemical laboratories—The Bursar, The Alington Hall, The Schools, Shrewsbury.

Research Assistants (2) in the Cytology Department in the Senior Scientific Officer, Scientific Officer and Assistant Experimental Officer grades, and a Librarian (woman) with interest in scientific research—The Director, John Innes Horticultural Institution, Merton, London, S.W.19.

Assistantship in Entomology in the Department of Agricultural and Forest Zoology—The Secretary, The University, Edinburgh.

Research Demonstrator in Botany and Zoology in the Department of Biology—The Registrar, University College, Singleton Park, Swansea.

Physicists to carry out investigations on the physical properties of leather, Chemists to carry out investigations on (*a*) the organic chemistry of the vegetable tannins, (*b*) the processing of leather and elucidation of tannery problems, and a Biologist to work mainly on the micro-biological problems of the industry—The Director of Research, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

Laboratory Assistant in the Department of Biochemistry—The Establishment Officer, University College London, Gower Street, London, W.C.1.

Laboratory Assistant to take charge of Chemistry Department—The Bursar, The College, Cheltenham.

Expert in Soap Manufacture, Department of Commerce and Industries, Government of Ceylon—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.17602.

Laboratory Technician (Grade B) with general experience in clinical pathology, at St. Margaret's Hospital, Stratton St. Margaret, Swindon—The County Medical Officer, County Hall, Trowbridge, Wilts.

Lecturer in Radio Engineering—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Sir Jesse Boot Chair of Chemistry—The Registrar, University College, Nottingham.

Graduate Lecturer in Mechanical Engineering Subjects at the Lincoln Technical College—The Director of Education and Clerk to the Governors, City Education Offices, 4 Lindum Road, Lincoln.

Senior Lecturer in Education in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

International Council of Scientific Unions. Fourth General Assembly of the International Council of Scientific Unions held at London, July 22nd to 24th, 1946. Reports of Proceedings. Edited by F. J. M. Stratton. Pp. viii + 128. (Cambridge: At the University Press, 1946.) [133

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Bulletin of the American Museum of Natural History. Vol. 88, Article 2: Studies of the Phytosaurs *Machaeroprosopus* and *Rutiodon*. By Edwin Harris Colbert. Pp. 53–96 + plates 3–10. Vol. 88, Article 3: Results of the Archbold Expeditions, No. 56, On the Anatomy and Classification of the Dasyuridae (Marsupialia). By G. H. H. Tate. Pp. 97–156. (New York: American Museum of Natural History, 1947.) [133

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 25, No. 16: Alice Eastwood Semi-Centennial Publications, No. 16, Endemism in the Hawaiian Flora, and a Revision of the Hawaiian Species of *Gunnera* (Haloragidaceae). By Prof. Harold St. John. (Hawaiian Plant Studies, 11.) Pp. 377–420 (plates 37–46). Vol. 25, No. 17: Alice Eastwood Semi-Centennial Publications, No. 17, A Revision of the *Artemisia vulgaris* complex in North America. By David D. Keck. Pp. 421–468. Vol. 25, No. 18: Alice Eastwood Semi-Centennial Publications, No. 18, The Genus *Ruppia* L. By William A. Setchell. Pp. 469–478 (plates 47–48). (San Francisco: California Academy of Sciences, 1946.) [133

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NATIONAL PARKS

IN 1872 the first national park in the world, the Yellowstone National Park, was established by an Act of Congress, and it is still the most noted of all American national parks. It lies mainly in the State of Wyoming and is sixty-two miles long and fifty-four miles wide. The scenery in this park is of exceptional grandeur and beauty, and the park contains many natural features of outstanding interest —forests, alpine flora, a very varied terrestrial and aquatic fauna, more than a hundred geysers and four thousand hot springs, and the Grand Canyon of the Yellowstone. It can be no cause for wonder, therefore, that such a unique area should have been taken over for the enjoyment of all almost as soon as it was first surveyed. Since then, as stated by Dr. Herbert Smith in his article on "Nature Protection in Great Britain" (p. 457 of this issue), the idea of national parks has spread throughout the world and in many places been put into effect. Some, such as that in the Belgian Congo, are very extensive ; others are comparatively small.

But national parks need not necessarily be confined to areas of exceptional merit or interest ; moreover, as pointed out in Dr. Smith's article, the *raison d'être* of a national park is not simply public pleasure or scientific study ; it must perform a multiple function. This casts our minds back to December 8, 1938, when the Linnean Society of London met to discuss the objects of national parks. The discussion arose from a letter sent by Prof. J. B. Cleland, chairman of the Commissioners of the National Park at Belair, South Australia, who asked the Society for a definition of a national park, and to express an opinion as to how far facilities for sport and recreation should be allowed to replace the original fauna and flora, especially when the park is near a thickly populated area.

At that Linnean Society discussion, Sir Peter Chalmers Mitchell claimed that a national park should be an area under public control where wild animal and plant life is preserved and hunting and collecting only allowed under licence ; but he also agreed that it would be unreasonable to hand over smaller parks near towns for the exclusive use of naturalists. Dr. Julian Huxley maintained that, at any rate in Great Britain, within a national park, recreation, walking and camping in unspoilt countryside must take precedence over the preservation of flora and fauna. Dr. Herbert Smith himself suggested that the two main aims of national parks—scientific and recreational—are not incompatible. Other views expressed at that discussion tended to support the idea that, under intelligent control, a national park could be a sanctuary where plants and animals could thrive under natural conditions (though it must be borne in mind that these conditions are dynamic, not static), yet also afford facilities for recreation and sport even if these may have to be limited to certain well-defined areas within the park.

Apart from their multiple functions, national parks will vary, of course, according to their individual characters. Though the Linnean Society's discussion was held nine years ago, the idea of the establishment of national parks in Britain has gained ground and several important reports have been published since. These are discussed by Dr. Herbert Smith in the article published in this issue.

It is well that in a small country such as Britain the conception of the form and function of national parks should be thoroughly discussed before any large-scale plans are formulated and then put into effect. As Dr. Smith points out, Britain has a beautiful landscape varying considerably in character; in fact, the variation itself is worthy of note. So to preserve this for posterity the establishment of national parks is essential. In the discussions and reports so far published, Nature preservation and respect for geological monuments loom large; but in the latest report, that of the National Parks Committee of the Ministry of Town and Country Planning recently published, it is emphasized that the function of national parks should be "more the spiritual and bodily refreshment of the people, especially the inhabitants of cities and towns, than the protection of wild life". Furthermore, considerable tact and caution are necessary when deciding what priority or privileges should be given to *bona fide* students of natural history over the general lay public. For example, complaint has already appeared in the newspaper press about the closing of Flatford Mill (immortalized by Constable) to the general public in favour of students. No matter what facts lie behind the acquisition of any monument, it is desirable that public opinion be taken into full consideration before final policy is settled, especially since it seems to be agreed that spiritual and bodily refreshment of the general public is of paramount importance. In other words, the authorities who have the final say in choosing and administering national parks should aim at preventing different interests from becoming clashing interests and so conflicting with each other. On the contrary, they should aim at utilizing such parks as places where not only may each interest be satisfied so far as is commensurate with the common weal, but also where one interest can meet the other to the benefit of both—a symbiosis of interests.

Thus might become established that nucleus of biological service, as Dr. Smith envisages and Dr. E. Hindle in his presidential address to Section D (Zoology) of the British Association meeting at Dundee this year pleaded for, which would offer the best field opportunities for the natural historian working among the lay public, who would conceivably watch his work with interest. Here would be an arena where work and play could move together hand in hand.

Difference in character must also be taken into account. A park in the Scottish Highlands would be unlike one in the Lake District, and again very different from one on the rolling downs of the south of England. This would need serious consideration when deciding on organisation and personnel for administration and control.

SCIENTIFIC AND TECHNICAL BOOKS

As one of the measures for reducing British expenditure in countries in the 'dollar area', it has been announced that restrictions are being imposed on the importation into Britain of books. At a time when emphasis is being placed increasingly on the importance of international understanding, it is most unfortunate that this particular medium should have been selected as a means of effecting economies; books are surely one of the best means of making one people acquainted with another. Here we are concerned mainly with scientific and technical books, and the restriction will in practice apply chiefly, though not entirely, to American books. The position is that scientific and technical books may no longer be imported except under individual licence. British publishers have to submit to the licensing authorities evidence of the value of their pre-war imports of such books, and they will be given a licence to import foreign books to the same annual value. Thus we return, at a stroke, to the maximum war-time restrictions. Publishers will now have to apply quarterly for licences to import specified quantities of named books, and giving in each case the name of the exporting country.

There are some observations on such a scheme which immediately come to mind. First there is the vexatious delay in obtaining a necessary book, should the British publisher have no copy in stock. Further, in imposing this form of individual licence, the Government is in effect instituting a system which might easily become a form of censorship. A more immediate objection is that the present scheme is based on money value, and takes no account of the increase in book production costs. So far as American books are concerned, prices are 50 per cent and more above the pre-war figure for corresponding books. In effect, therefore, the number of scientific and technical books of American origin it will be possible to import into Britain will be substantially less than the figure for 1939.

It is becoming generally accepted that the utmost efficiency is necessary in the scientific and technical fields to enable Britain to recover its position in the world. Yet by cutting down supplies of the essential books, the Government is putting an important obstacle in the path; and this at a time when there is an acute shortage of school and university text-books and also of standard works of reference. It may be urged that some American text-books are not suited for the courses in British schools and universities, but that argument cannot be applied to research monographs and reference works; these, with the all-important specialist periodicals, are essential tools for the scientific worker trying to keep abreast of modern developments.

While it must be granted that restrictions on general expenditure are necessary, it would seem that scientific and technical books should have a high priority in the permissible expenditure of dollars; and it should be possible to devise a scheme whereby such books are made more readily available.

DUTCH PIONEERS IN SCIENCE AND INDUSTRY

Nederlandsche Baanbrekers der Wetenschap
Door J. C. Alders. Pp. 201. (Amsterdam: Bigot and Van Rossum N.V., n.d.) n.p.

THIS book contains excellent popular descriptions of the work of the Dutch pioneers of science and industry during the last fifty years. The sciences included in this book are astronomy, biology, chemistry and physics, and the industries agriculture, aviation, mineral oil, radio and tin. The book is really about the subjects mentioned, but it is arranged biographically. Of the many famous names mentioned, which include Nobel Prize winners, are the following: Kamerlingh Onnes, Van der Waals, Lorentz, Zeeman, Debye, de Vries, Fokker; and reference is made to the Philips laboratory at Eindhoven.

It was in 1895 that Zeeman discovered that in a plane parallel to an intense magnetic field each line of the spectrum of a sodium or lithium flame placed in the field became a doublet, whereas if the light was examined spectroscopically in a direction at right angles to the field, there was each ordinary line together with two components associated with it. When a spectroscope is pointed to the sun's centre, doublets are seen; whereas triplets appear if a sensitive spectroscope is directed at a point near the sun's periphery. Thus is demonstrated the sun's intense radial magnetic field. This work and other like it has led to the recent hypothesis of Blackett.

Van't Hoff was a pioneer in the mechanical theory of valency and in the connexion of the optical activity of many carbon compounds with their chemical constitution. The theorem known by his name connects the quantitative displacement of equilibrium with change of temperature, and he showed the analogy between dilute solutions and gases via their osmotic pressures.

De Vries was perhaps unlucky in his choice of the evening primrose (*Œnothera lamarckiana*) for his work on mutations in heredity and evolution, when he put forward his ideas of spurts or storms of mutation—because some of the changes from individual to individual have no evolutionary significance, since the supposedly new species and variations cannot breed true. The revived work of Mendel and later work on chromosomes have superseded the work of de Vries.

Vening Meinesz is particularly famous for gravity measurements at sea in a submarine. Between the years 1922 when the first test of Meinesz's two pendulums was carried out on S.S. *Paleleh* between Ymuiden and Flushing, and 1934 when he made a submarine trip via the Cape to the Dutch East Indies, Vening Meinesz was constantly engaged in improving his apparatus, testing it at sea, and working up the results obtained. During 1926–27 he undertook a voyage from Holland via Panama to Soerabaya, in 1929–30 to the Gulf of Mexico and to the Dutch East Indies, and in 1932 to the Azores and Cuba. In the Dutch East Indies, he made numerous gravity measurements and discovered an 'axis' where gravity is greater than expected, in some places by 65 milligalls. Next to this is a chain of gravity deficiencies, which chain runs through Sumatra, south of Java, across the Soenda Islands, through the Philippine Islands to Japan. This chain of approximately 100 km. width runs along with, or parallel to, the earthquake belt. In the Dutch East Indies volcanoes are on the landward side of the axis of Vening Meinesz. This axis is very significant in the realm of geophysics.

In the world of industry the Dutch have made great strides in our methods of working tin and oil; the work of Fokker in aeronautics and the laboratory of the Philips Co. are too well known to require enlarging upon here. Less well known, though no less important particularly at the present time, is the work of the Dutch Cultivation Co. and the Dutch potato flour industry.

From what has been described above it will be seen that this popularly written book will be of great value in putting before the general Dutch public and the world the contributions which her learned and industrious sons have made to Holland and the world, and will show that this is indeed great when one looks at the size and character of the countryside. The book is in Dutch, and the author of this notice is indebted to Mr. C. Knor for assistance with the translation. ERNEST TILLOTSON

THE U.S. PHARMACOPŒIA

The Pharmacopœia of the United States of America (the United States Pharmacopœia)
Thirteenth revision. By Authority of the United States Pharmacopœial Convention. Pp. cvii + 957. (Easton, Pa.: Mack Publishing Co., 1947.)

THE first United States Pharmacopœia appeared in 1820, and up to 1936 revisions appeared at intervals of about ten years. This interval has now been reduced to five years, owing to the rapid advance of therapeutics. The thirteenth revision (1947) is an impressive book containing more than a thousand pages, and much work has been put into its preparation. It is controlled by the U.S. Pharmacopœial Convention, which meets "upon the second Tuesday in May in the first year in each decade ending in zero". The number of delegates attending the convention in 1940 was 487, not counting guests from various neighbouring countries, of which Costa Rica, Cuba, Dominican Republic, Nicaragua, Panama and Uruguay have given official status to this Pharmacopœia. This convention elects a president, five vice-presidents, a secretary, an assistant secretary, a treasurer, a board of trustees and a general committee of revision consisting of sixty members. The board of trustees elects a director of pharmacopœial revision, and the general committee provides ten sub-committees, the chairmen of which constitute the executive committee of revision. These details and many more are given in the introductory pages of the Pharmacopœia.

The complex organism thus sketched is rich, partly because much of the work is unpaid and carried out from a sense of public duty. It is unfortunate that a good deal of it is duplicated in other countries in order to produce many other pharmacopœias suited to local conditions. The time is surely coming when an international pharmacopœia will be accepted all over the world. Some steps in this direction have been made; but progress is slow. An organisation such as the Americans have provided might produce a truly international pharmacopœia, though, unfortunately, most other countries are afraid of being swamped. The advantages of internationalization in this field are, however, so great that every effort should be made in this direction. One difficulty lies in the fact that the trend of therapeutic practice differs in different countries. It seems strange that the

Americans are at this moment removing 'Pamaquine' and chaulmoogra oil from their Pharmacopœia. They do not include leptazol, or nikethamide, or lobeline, and seem to rely on picrotoxin as the only official analeptic. They include no acridine antiseptic.

Another difficulty is the question of nomenclature. New pharmacopœias generally contain a few new names for old drugs and omit the old names, which are unsuitable for official use for one reason or another. Sometimes these new names explain themselves; benzalkonium is fairly obviously a cationic detergent. Sometimes their interpretation forms a test of general knowledge. Iodopyracet is the new American name for diodone, which is used to display the renal pelvis under X-rays. Some readers will no doubt be driven to other works of reference to confirm the fact that these two substances are, in fact, identical.

Some attempt is made to achieve agreement about such neologisms between the British and the Americans, but the results are disappointing. The Americans use 'f' where the British use 'ph', and simplify spelling in various other ways. The drugs known in America as epinephrine, menadione, tetracaine, quinacrine, and anhydrohydroxyprogesterone are known in Britain as adrenaline, menaphthone, amethocaine, mepacrine and ethisterone respectively.

The new work contains many admirable features. The official names have been chosen so as to bring allied preparations together in the alphabetical arrangement; for example, tincture of opium is called opium tincture, so that it comes near opium itself. Metric doses have precedence over avoirdupois; this convention will be welcomed internationally. English names have precedence over Latin names; this convention will be welcomed in English-speaking countries. There is much incidental information about the properties of a wide range of substances which are only occasionally used by pharmacists as reagents, and about the measurement of viscosity, *p*H, turbidity, melting points, optical relation, etc.

Methods of biological assay are described for such substances as epinephrine, posterior pituitary, insulin, vitamins A, B and D, and all preparations containing cardiac glycosides, and there are microbiological methods for nicotinamide and riboflavin. Such biological methods are not applied to pure active principles such as epinephrine or ouabain, but they are applied to preparations of these active principles, such as epinephrine solution or ouabain injection. In these cases, the assay is clearly not intended to be applied to each sample, but only used in cases of doubt or dispute. In the case of other drugs, such as insulin and digitalis tincture, the assay forms an integral part of the manufacture, and the exact procedure is prescribed in great detail, which leaves much less to the discretion of the individual than is the custom in Britain. Some of the details of the techniques will no doubt be criticized. Cats are to be used for the assay of digitalis, and methods using frogs are not recognized. There is no convincing evidence to justify this decision. Rabbits, and not mice, are to be used for the assay of insulin, and they must receive three doses of the unknown preparation and one dose of the standard, instead of two doses of each, as is customary here. The attempt to make these tests foolproof has made them too rigid.

The assays of various vitamins are not designed to measure their concentration, but only to ensure a certain minimum activity. This decision greatly simplifies the interpretation of the result. The standard preparations to be used for these assays are distributed officially; the Pharmacopœia seems to contain no information about their composition. It would be interesting to have been told whether the standard for vitamin D in cod liver oil is vitamin D_3, as it ideally should be, or calciferol.

For various reasons, some of which are mentioned above, this Pharmacopœia could not be officially adopted as it stands in Great Britain, but it contains much that we can admire, and might copy. The Americans are to be congratulated on a fine piece of work.

J. H. Gaddum

METHODS IN CELLULOSE CHEMISTRY

The Methods of Cellulose Chemistry

Including Methods for the Investigation of Substances associated with Cellulose in Plant Tissues. By Dr. Charles Dorée. Second edition, revised and enlarged. Pp. xii+543. (London: Chapman and Hall, Ltd., 1947). 42*s*. net.

THE earlier edition of this book has been of very great value to all whose interests have been in the field of cellulose chemistry, and there can be no doubt, therefore, of the welcome which will be accorded to a second edition. The full usefulness of the volume can be appreciated only when the complete title is considered, since the reader will find, in addition to the multifarious methods of investigation applicable to cellulose and its derivatives, concise accounts of the methods of attack which have been developed for investigations on lignin, hemi-celluloses and pectic materials.

Much has been added to our knowledge of all these substances in the course of the fifteen years which have elapsed since the first edition was published, and Dr. Dorée has now undertaken with conspicuous success the formidable task of incorporating new matter and revising the old. No fundamental changes have been found necessary, but a great deal of new material now finds its place in the book. In Part I methods used in the examination of normal cellulose are collected, including the measurement of physical properties, methods of analysis applicable to cellulose, mercerized cotton, rayons, hydrocelluloses and oxycelluloses. There is a chapter devoted to the investigation of damage in cotton and linen fabrics. The second part is concerned with synthetic derivatives of cellulose, including esters and ethers, and on this topic much new matter has been added in the present edition. The third part deals with the compound celluloses, and in addition to a chapter on the qualitative and quantitative examination of plant tissues there are detailed accounts of procedures for the estimation of cellulose and lignin, and of the standard methods for the estimation of furfural, uronic acid and methoxyl. Chapters are included also on the analysis of wood, and on the chemistry of lignin and the hemi-celluloses.

The book is designed for use by the practical worker in the laboratory. It is well illustrated with figures and graphs and is fully documented. Precise and detailed directions are given for all the analytical procedures. The comprehensive author- and subject-indexes facilitate reference, and the book has been excellently produced in a clear type which is a pleasure to read. Dr. Dorée is to be warmly congratulated on the appearance of this second edition of a most useful and valuable work.

E. L. Hirst

PEACEFUL APPLICATIONS OF NUCLEAR FISSION

A SYMPOSIUM on the "Peaceful Applications of Nuclear Fission" was arranged by Section A (Mathematics and Physics) at the recent meeting of the British Association at Dundee. It was opened by the president of the Section, Sir Edward Appleton, who said that no scientific subject had ever aroused quite the same mixture of hopes and fears. At that meeting they were to concentrate on the hopes; in due course the work conducted on the development of the atomic bomb would lead to the saving of far more lives than were lost in the attacks on Japan.

Dr. J. D. Cockcroft remarked that the peace-time applications of nuclear fission would result from the achievement of a divergent nuclear chain reaction in the atomic pile—first built by Prof. E. Fermi in the University of Chicago in 1942. The fission pile provides a much more powerful source of neutrons than the largest cyclotron. The pile would make possible new types of experiments in nuclear physics and would be the main source of radioactive isotopes. With the production of neutrons goes the development of heat, and the pile is a *potential* though not certain new source of power for the world.

The first objective of the Atomic Energy Research Establishment at Harwell, Berks, had been the construction of a low-power graphite pile known as "G.L.E.E.P." similar to that now in use at the Argonne National Laboratory in Chicago. This pile consists of several hundred tons of graphite bricks between which are grooves for the insertion of uranium metal and uranium oxide. Surrounding the pile is a shield of concrete about 5 ft. in thickness. This is required to reduce the intensity of the neutron and gamma radiation developed inside the pile to tolerance-levels. The shield is pierced with holes for control instruments, control rods, safety rods and for 'thermal columns' to bring neutrons of thermal energy out to the shield face for experiments.

The concrete shield and its accessories took about a year to build. Loading of the uranium started on August 5 and was completed by August 15 of this year. During the loading of the uranium the multiplication constant, k, of the pile increased towards unity, and since one neutron released in the spontaneous fission of a U238 nucleus leads to $1 + k + k^2$ or $1/(1 - k)$ neutrons, the course of approach to the critical or divergent state is followed by recording by a boron trifluoride-filled counter the flux of neutrons inside the pile. Thus on August 7, when 7 tons of uranium had been loaded, the counter recorded 17 neutrons per minute. By August 11 this had increased to 55 neutrons/minute, by the morning of August 15 to 2,400 and by early afternoon to 6,600 per minute. At this point the counter was saturated—the pile being almost divergent. During the last stages of loading, the control rods were partially inserted, reducing k slightly. Uranium was then loaded until the divergent point was just passed. At this stage the pile generated about 0·1 watt of thermal energy. The power-level increases exponentially with time but with a very long period. The period depends on $1/(k - 1)$, and with an excess of k of 1/40,000 the period is one hour. The pile is therefore very easy to control. A withdrawal of the control rods led to a decrease of the period to about a minute and the power-level was allowed to increase to 100 watts, at which level ionization chambers had been pre-set to release the shut-off rods and shut down the pile. The first objective of the Harwell work had, therefore, been realized in about fifteen months.

Measurements would now be carried out to determine all the pile characteristics. This was expected to take about one month. After that the power-level would be increased to a level set by the safe operating temperature of the uranium. In this pile only very simple cooling is used, and it would probably be necessary to limit the average power to about 50 kilowatts. At this power-level there would be a maximum thermal neutron flux of 10^{10} neutrons/sq.cm./sec.; the total number of neutrons generated would be about 3×10^{15} per sec., of which about one per cent could be used for production of radioactive isotopes or for experimental work. It was intended to start radioactive isotope production immediately. Some isotopes could be produced in adequate intensities by this pile—thus it is estimated that 5–10 curies per month of radiophosphorus could be produced monthly by the capture of neutrons in phosphorus. Production of high specific activity P^{32} by the (n,p) reaction in sulphur would be considerably smaller. Long-lived isotopes such as C^{14} could only be produced in small quantities, and adequate production would have to await the completion of the second Harwell pile.

One of the principal applications of the low-power pile is the study of the nuclear reactions of elements with slow neutrons. The introduction of as little as 0·1 mgm. of cadmium into the pile produces a detectable change of power-level; and from the rate of change, the absorption cross-section for slow neutrons can be determined. In practice, specimens under investigation are moved into and out of the pile with a period of 20 sec. or so and the amplitude of oscillation of the power-level measured by a resonant galvanometer or other suitable methods. A pile of this type is an indispensable tool for the control of nuclear properties of all basic materials used in the construction of piles.

The power-level of a pile can be increased by more intensive cooling of the uranium metal, and in the second Harwell pile the metal rods will be cooled by a high-speed stream of air flowing past the rods. In this way the power-level could be increased to several thousand kilowatts. The uranium metal would be sheathed with aluminium to prevent oxidation and escape of fission products. The decreasing creep strength of aluminium with increasing temperature would probably limit surface temperatures to about 350° C., and emergent gas temperatures would therefore be limited to about 300° C. Although this is not high enough for efficient power production, a heat exchanger would be placed in the emerging gas stream and some use made of the pile heat.

The emergent gas temperature could be increased if a material having more favourable properties could be substituted for aluminium. Metals such as steel would reduce the multiplication constant below unity; beryllium would be suitable if it could be produced in ductile form.

The second Harwell pile will be used to study problems of power production. Thus it is important to study the effect of neutron irradiation on the physical properties of materials used in piles—it is known that some deterioration takes place. It is also important to study the effect of formation of fission products on the multiplication constant of the pile, and in particular the effect of the partial substitution of U235 by plutonium in the pile.

It is expected that the neutron flux and available neutrons will be of the order of a hundred times that available in the G.L.E.E.P. This would make possible the full production of most radioactive isotopes required in Britain. A few isotopes would be limited in quantity.

This pile would also provide a powerful source of fission products—which are distributed among the thirty-five elements from zinc to gadolinium. At 1,000 kW. power-level, about a gram a day of fission products would be produced.

Other types of pile important for scientific research include the heavy-water piles. These piles have a higher multiplication constant than the graphite pile, and would use a substantially smaller amount of uranium and moderator. For a fixed power output they could give a much higher neutron flux, and this is very important for some experiments and for the study of future developments. A high-power heavy-water pile has recently been completed at Chalk River by the Canadian National Research Council, and will provide an important experimental tool for atomic energy research.

The future of the application of nuclear fission to the large-scale development of power is at present obscured by lack of information on a number of essential points.

A pile using natural uranium sheathed by aluminium and cooled by a circulating gas could be used for steam generation and power production by a steam turbine. Experimental plants of this type would probably be built, though their thermodynamic efficiency would be low, due to the temperature limit of aluminium. If Nature were exceptionally kind, a plant of this kind containing 100 tons of uranium would generate 100,000 kW. of thermal energy for twenty years without fuel replacement. Actually, however, the formation of fission products will probably lead to poisoning of the chain reaction due to their additional absorption, and difficulties may be experienced due to deterioration of materials under the intense neutron bombardment of the pile. The metal will, therefore, have to be withdrawn at frequent intervals, the fission products extracted and the uranium and plutonium reprocessed. Until operating experience tells us how frequently this will have to be done, and what the costs will be, it is not possible to predict the costs of nuclear power. The position about reserves of nuclear fuel is equally uncertain at the present time, since the proportion of the uranium which can be used is unknown.

So far, piles have used only a fraction of the energy of U235. In the future, we may hope to do considerably better than this. As a pile burns up the primary fuel atoms of U235, the neutrons released in the fission can turn U238 into plutonium, which is fissionable by slow neutrons and is a secondary fuel just as good as U235. One U235 atom will in general be replaced by rather less than one plutonium atom; this in turn will be partially replaced. The overall result is that there is a possibility of utilizing more than the fission energy of U235. Ideally we might go a long way towards reaching the full utilization of U238—how far we can go we do not know.

There is also a possibility of utilizing the fission energy of thorium by turning it into U233, which is also fissionable by slow neutrons.

One other major uncertainty stands in the way. With nuclear power goes a very large-scale production of radioactive materials. A power plant generating the thermal energy of a million kilowatts produces daily an activity of the order of a million curies even after an appreciable decay is allowed for. A world run on nuclear power would generate at least a hundred times this activity. The safe disposal of these products presents a major problem.

Prof. O. R. Frisch described the application of the fission pile to nuclear research. A high-power pile of the type being built at Harwell would produce very large numbers of fast and slow neutrons. Experiments requiring fast neutrons continue to be carried out, for the most part, on cyclotrons, which provide a point source of fast neutrons, whereas the pile neutrons are spread out over several thousand cubic feet of pile volume. The pile has, however, a decisive advantage for experiments with slow neutrons, since the cyclotron source becomes diffuse in slowing down the neutrons. Experimental work was described using a mechanical velocity selector to study the velocity distribution of slow neutrons emerging from the pile. Filtering through graphite has been shown to reduce their mean velocity by a factor of 4 owing to their wave properties leading to selective transmission through the graphite lattice. This is due to the absence, for very slow neutrons, of lattice planes fulfilling the Bragg reflexion condition. On the other hand, homogeneous neutron beams can be obtained by Bragg reflexion from crystals, and the crystal spectrometer provides a powerful method of studying neutron-capture phenomena. It is expected also that neutron scattering from hydrogen atoms in crystals may result in neutron spectroscopy being a valuable tool for the organic chemist. Slow neutrons have been shown to be totally reflected at glancing angles; this proves that the refractive index of the materials used (glass, graphite, etc.) is less than unity for neutron waves. The intense beam of pile neutrons would make it worth while to look for the decay of the neutron into a proton and an electron.

Mr. W. G. Marley described the production of radioactive isotopes in a pile. The simplest procedure is to produce them by neutron capture, that is, by (n,γ) reactions. The materials to be irradiated are placed in the reflector of the pile, where up to one-fortieth of the pile neutrons can be absorbed for this purpose.

Some biological experiments require a high specific activity—500 millicuries per gram of materials. For this purpose it might be necessary to use (n,p) reactions, for example, in $S^{32}(n,p)P^{32}$. Many of these reactions require fast neutrons and can only be produced in the core of the pile, where the available neutrons will be only about one-tenth of those available in the reflector. A few isotopes such as tritium would be produced by (n,α) reactions. The high-power Harwell pile would be able to produce quantities of most isotopes more than adequate for all likely requirements. A few long-lived isotopes such as tritium, C14, Cl37, would be limited by pile capacity, though an annual production of 4–5 curies of C14 should be possible.

It is expected that a few radioactive isotopes, such as Na22, will still have to be produced in the cyclotron, since they can only be produced by neutrons by $(n, 2n)$ reactions requiring very fast neutrons.

Radioactive isotopes produced by (n,p) reactions would require chemical separation; and when the processes have been established at the Harwell station, routine separation will be carried out by the Radiochemical Centre of the Ministry of Supply. The allocation of radioactive isotopes will be carried out by a sub-committee of the Advisory Council for the Radiochemical Centre. This sub-committee, under the chairmanship of Dr. J. D. Cockcroft, includes representatives of user interests—the Medical and Agricultural Research Councils and the Department of Scientific and Industrial Research, which will represent the universities and industry.

Radioactive isotopes from piles in the United States have been available to American users only since 1946, and a large number of applications to medical, biological and industrial research have already been found, while the future has been declared by Dr. G. Seaborg to hold unlimited possibilities.

J. D. COCKCROFT

OBSERVATIONS ON THE TRACKS OF SLOW MESONS IN PHOTOGRAPHIC EMULSIONS*

By C. M. G. LATTES, DR. G. P. S. OCCHIALINI and DR. C. F. POWELL

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INTRODUCTION. In recent experiments, it has been shown that charged mesons, brought to rest in photographic emulsions, sometimes lead to the production of secondary mesons. We have now extended these observations by examining plates exposed in the Bolivian Andes at a height of 5,500 m., and have found, in all, forty examples of the process leading to the production of secondary mesons. In eleven of these, the secondary particle is brought to rest in the emulsion so that its range can be determined. In Part 1 of this article, the measurements made on these tracks are described, and it is shown that they provide evidence for the existence of mesons of different mass. In Part 2, we present further evidence on the production of mesons, which allows us to show that many of the observed mesons are locally generated in the 'explosive' disintegration of nuclei, and to discuss the relationship of the different types of mesons observed in photographic plates to the penetrating component of the cosmic radiation investigated in experiments with Wilson chambers and counters.

Part I. Existence of Mesons of Different Mass

As in the previous communications[1], we refer to any particle with a mass intermediate between that of a proton and an electron as a meson. It may be emphasized that, in using this term, we do not imply that the corresponding particle necessarily has a strong interaction with nucleons, or that it is closely associated with the forces responsible for the cohesion of nuclei.

We have now observed a total of 644 meson tracks which end in the emulsion of our plates. 451 of these were found, in plates of various types, exposed at an altitude of 2,800 m. at the Observatory of the Pic du Midi, in the Pyrenees; and 193 in similar plates exposed at 5,500 m. at Chacaltaya in the Bolivian Andes. The 451 tracks in the plates exposed at an altitude of 2,800 m. were observed in the examination of 5 c.c. emulsion. This corresponds to the arrival of about 1·5 mesons per c.c. per day, a figure which represents a lower limit, for the tracks of some mesons may be lost through fading, and through failure to observe tracks of very short range. The true number will thus be somewhat higher. In any event, the value is of the same order of magnitude as that we should expect to observe in delayed coincidence experiments at a height of 2,800 m., basing our estimates on the observations obtained in similar experiments at sea-level, and making reasonable assumptions about the increase in the number of slow mesons with altitude. It is therefore certain that the mesons we observe are a common constituent of the cosmic radiation.

Photomicrographs of two of the new examples of secondary mesons, Nos. III and IV, are shown in Figs. 1 and 2. Table 1 gives details of the characteristics of all events of this type observed up to the time of writing, in which the secondary particle comes to the end of its range in the emulsion.

TABLE 1

Event No.	Range in emulsion in microns of Primary meson	 Secondary meson
I	133	613
II	84	565
III	1040	621
IV	133	591
V	117	638
VI	49	595
VII	460	616
VIII	900	610
IX	239	666
X	256	637
XI	81	590

Mean range 614 ± 8 μ. Straggling coefficient $\sqrt{\Sigma\Delta_i^2/n} = 4\cdot3$ per cent, where $\Delta_i = R_i - \bar{R}$, R_i being the range of a secondary meson, and $\bar{R}$ the mean value for n particles of this type.

The distribution in range of the secondary particles is shown in Fig. 3. The values refer to the lengths of the projections of the actual trajectories of the particles on a plane parallel to the surface of the emulsion. The true ranges cannot, however, be very different from the values given, for each track is inclined at only a small angle to the plane of the emulsion over the greater part of its length. In addition to the results for the secondary mesons which stop in the emulsion, and which are represented in Fig. 3 by black squares, the length of a number of tracks from the same process, which pass out of the emulsion when near the end of their range, are represented by open squares.

The μ-Decay of Mesons

Two important conclusions follow from these measurements. Our observations show that the directions of ejection of the secondary mesons are orientated at random. We can therefore calculate the probability that the trajectory of a secondary

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* This article contains a summary of the main features of a number of lectures given, one at Manchester on June 18 and four at the Conference on Cosmic Rays and Nuclear Physics, organised by Prof. W. Heitler, at the Dublin Institute of Advanced Studies, July 5-12. A complete account of the observations, and of the conclusions which follow from them, will be published elsewhere.

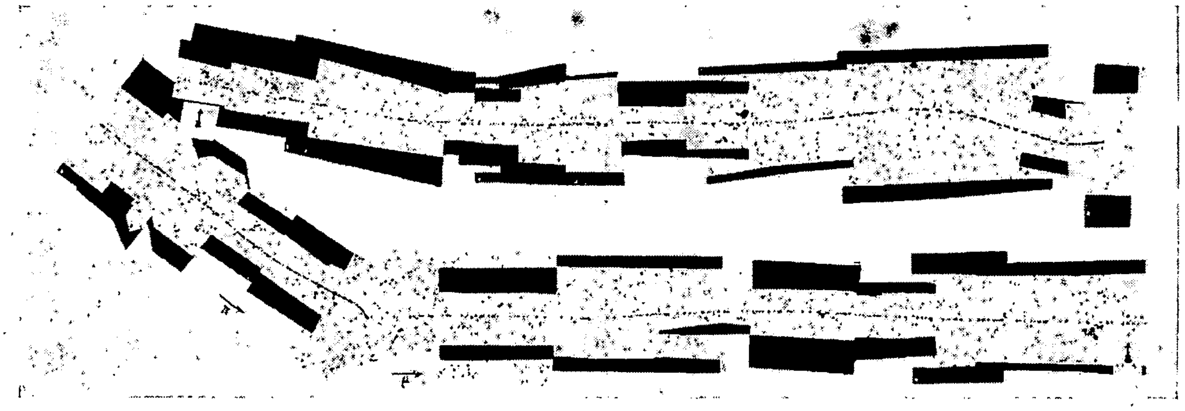

Fig. 1. OBSERVATION BY MRS. I. POWELL. COOKE × 95 ACHROMATIC OBJECTIVE; C2 ILFORD NUCLEAR RESEARCH EMULSION LOADED WITH BORON. THE TRACK OF THE μ-MESON IS GIVEN IN TWO PARTS, THE POINT OF JUNCTION BEING INDICATED BY a AND AN ARROW

meson, produced in a process of the type which we observe, will remain within the emulsion, of thickness 50 μ, for a distance greater than 500 μ. If we assume, as a first approximation, that the trajectories are rectilinear, we obtain a value for the probability of 1 in 20. The marked Coulomb scattering of mesons in the Nuclear Research emulsions will, in fact, increase the probability of 'escape'. The six events which we observe in plates exposed at 2,800 m., in which the secondary particle remains in the emulsion for a distance greater than 500 μ, therefore correspond to the occurrence in the emulsion of 120 ± 50 events of this particular type. Our observations, therefore, prove that the production of a secondary meson is a common mode of decay of a considerable fraction of those mesons which come to the end of their range in the emulsion.

Second, there is remarkable consistency between the values of the range of the secondary mesons, the variation among the individual values being similar to that to be expected from 'straggling', if the particles are always ejected with the same velocity. We can therefore conclude that the secondary mesons are all of the same mass and that they are emitted with constant kinetic energy.

If mesons of lower range are sometimes emitted in an alternative type of process, they must occur much less frequently than those which we have observed; for the geometrical conditions, and the greater average grain-density in the tracks, would provide much more favourable conditions for their detection. In fact, we have found no such mesons of shorter range. We cannot, however, be certain that mesons of greater range are not sometimes produced. Both the lower ionization in the beginning of the trajectory, and the even more unfavourable conditions of detection associated with the greater lengths of the tracks, would make such a group, or groups, difficult to observe. Because of the large fraction of the mesons which, as we have seen, can be attributed to the observed process, it is reasonable to assume that alternative modes of decay, if they exist, are much less frequent than that which we have observed. There is, therefore, good evidence for the production of a single homogeneous group of secondary mesons, constant in mass and kinetic energy. This strongly suggests a fundamental process, and not one involving an interaction of a primary meson with a particular type of nucleus in the emulsion. It is convenient to refer to this process

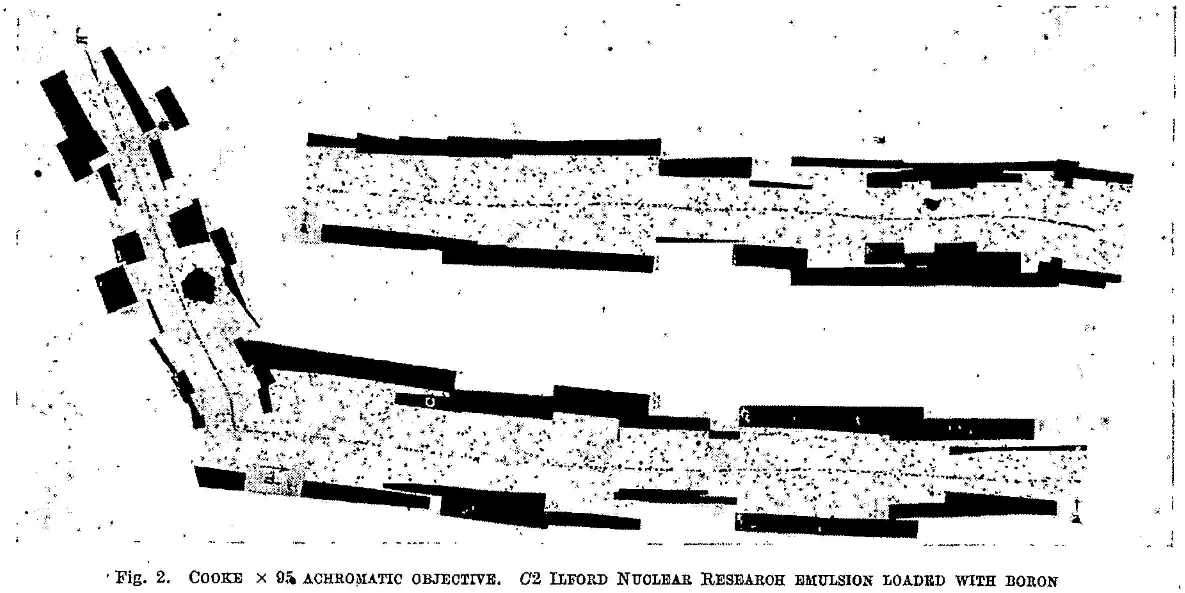

Fig. 2. COOKE × 95 ACHROMATIC OBJECTIVE. C2 ILFORD NUCLEAR RESEARCH EMULSION LOADED WITH BORON

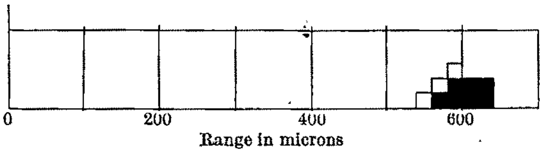

Fig. 3. DISTRIBUTION IN RANGE OF TEN SECONDARY MESONS. THOSE MARKED ■ STOP IN THE EMULSION; THE THREE MARKED □ LEAVE THE EMULSION WHEN NEAR THE END OF THEIR RANGE. MEAN RANGE OF SECONDARY MESONS, 606 MICRONS. THE RESULTS FOR EVENTS NOS. VIII TO XI ARE NOT INCLUDED IN THE FIGURE

in what follows as the μ-decay. We represent the primary mesons by the symbol π, and the secondary by μ. Up to the present, we have no evidence from which to deduce the sign of the electric charge of these particles. In every case in which they have been observed to come to the end of their range in the emulsion, the particles appear to stop without entering nuclei to produce disintegrations with the emission of heavy particles.

Knowing the range-energy relation for protons in the emulsion, the energy of ejection of the secondary mesons can be deduced from their observed range, if a value of the mass of the particles is assumed. The values thus calculated for various masses are shown in Table 2.

TABLE 2

Mass in m_e	100	150	200	250	300
Energy in MeV.	3·0	3·6	4·1	4·5	4·85

No established range-energy relation is available for protons of energies above 13 MeV., and it has therefore been necessary to rely on an extrapolation of the relation established for low energies. We estimate that the energies given in Table 2 are correct to within 10 per cent.

Evidence of a Difference in Mass of π- and μ-Mesons

It has been pointed out[1] that it is difficult to account for the μ-decay in terms of an interaction of the primary meson with the nucleus of an atom in the emulsion leading to the production of an energetic meson of the same mass as the first. It was therefore suggested that the observations indicate the existence of mesons of different mass. Since the argument in support of this view relied entirely on the principle of the conservation of energy, a search was made for processes which were capable of yielding the necessary release of energy, irrespective of their plausibility on other grounds. Dr. F. C. Frank has re-examined such possibilities in much more detail, and his conclusions are given in an article to follow. His analysis shows that it is very difficult to account for our observations, either in terms of a nuclear disintegration, or of a 'building-up' process in which, through an assumed combination of a negative meson with a hydrogen nucleus, protons are enabled to enter stable nuclei of the light elements with the release of binding energy. We have now found it possible to reinforce this general argument for the existence of mesons of different mass with evidence based on grain-counts.

We have emphasized repeatedly[1] that it is necessary to observe great caution in drawing conclusions about the mass of particles from grain-counts. The main source of error in such determinations arises from the fugitive nature of the latent image produced in the silver halide granules by the passage of fast particles. In the case of the μ-decay process, however, an important simplification occurs. It is reasonable to assume that the two meson tracks are formed in quick succession, and are subject to the same degree of fading. Secondly, the complete double track in such an event is contained in a very small volume of the emulsion, and the processing conditions are therefore identical for both tracks, apart from the variation of the degree of development with depth. These features ensure that we are provided with very favourable conditions in which to determine the ratio of the masses of the π- and μ-mesons, in some of these events.

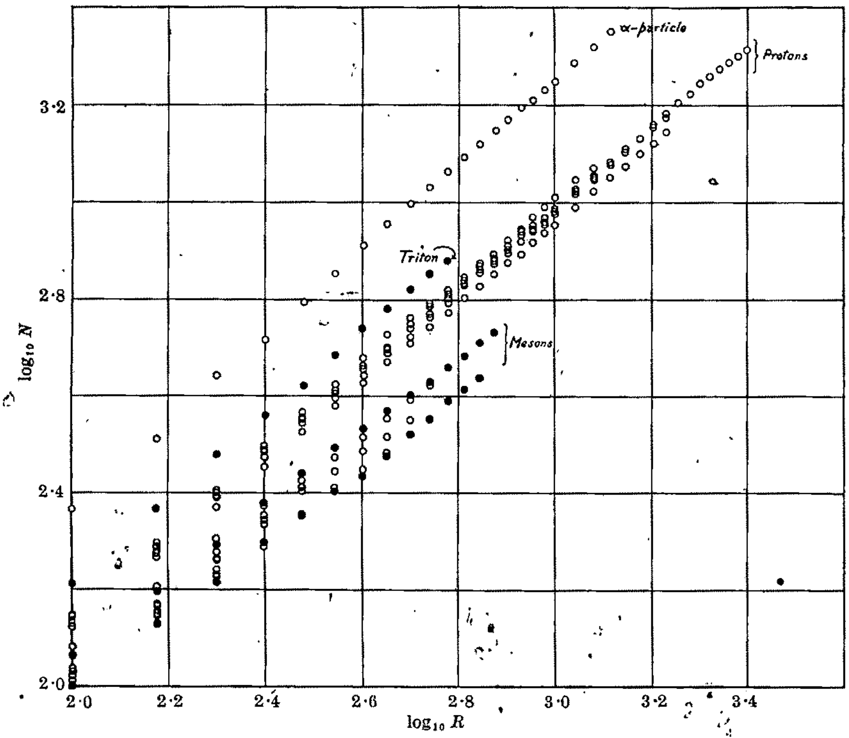

Fig. 4. N IS TOTAL NUMBER OF GRAINS IN TRACK OF RESIDUAL RANGE R (SCALE-DIVISIONS). 1 SCALE-DIVISION = 0·85 MICRONS

In determining the grain density in a track, we count the number of individual grains in successive intervals of length 50 μ along the trajectory, the observation being made with optical equipment giving large magnification (× 2,000), and the highest available resolving power. Typical results for protons and mesons are shown in Fig. 4. These results were obtained from observations on the tracks in a single plate, and it will be seen that there is satisfactory resolution between the curves for particles of different types. The 'spread' in the results for different particles of the same type can be attributed to the different degrees of fading associated with the different times of passage of the particles through the emulsion during an exposure of six weeks.

Applying these methods to the examples of the μ-decay process, in which the secondary mesons come to the end of their range in the emulsion, it is found that in every case the line representing the observations on the primary meson lies above that for the secondary particle. We can therefore conclude that there is a significant difference in the grain-density in the tracks of the primary and secondary mesons, and therefore a difference in the mass of the particles. This conclusion depends, of course, on the assumption that the π- and μ-particles carry equal charges. The grain-density at the ends of the tracks, of particles of both types, are consistent with the view that the charges are of magnitude | e |.

A more precise comparison of the masses of the π- and μ-mesons can only be made in those cases in which the length of the track of the primary meson in the emulsion is of the order of 600 μ. The probability of such a favourable event is rather small, and the only examples we have hitherto observed are those listed as Nos. III and VIII in Table 1. A mosaic of micrographs of a part only of the first of these events is reproduced in Fig. 1, for the length of the track of the μ-meson in the emulsion exceeds 1,000 μ. The logarithms of the numbers of grains in the tracks of the primary and secondary mesons in this event are plotted against the logarithm of the residual range in Fig. 5. By comparing the residual ranges at which the grain-densities in the two tracks have the same value, we can deduce the ratio of the masses. We thus obtain the result $m_\pi/m_\mu = 2\cdot0$. Similar measurements on event No. VIII give the value 1·8. In considering the significance which can be attached to this result, it must be noticed that in addition to the standard deviations in the number of grains counted, there are other possible sources of error. Difficulties arise, for example, from the fact that the emulsions do not consist of a completely uniform distribution of silver halide grains. 'Islands' exist, in which the concentration of grains is significantly higher, or significantly lower, than the average values, the variations being much greater than those associated with random fluctuations. The measurements on the other examples of μ-decay are much less reliable on account of the restricted range of the π-mesons in the emulsion; but they give results lower than the above values. We think it unlikely, however, that the true ratio is as low as 1·5.

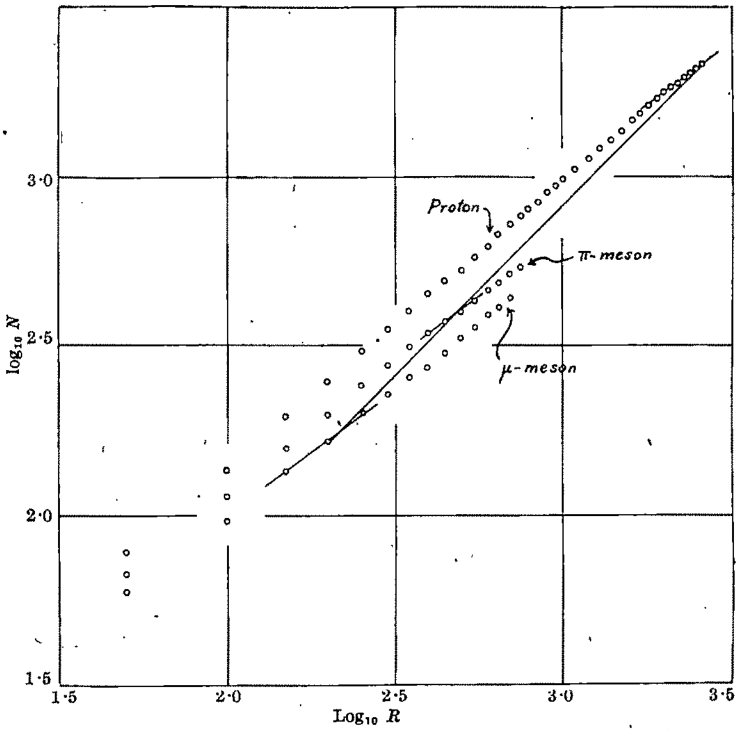

Fig. 5. N IS TOTAL NUMBER OF GRAINS IN TRACK OF RESIDUAL RANGE R (SCALE-DIVISIONS). 1 SCALE-DIVISION = 0·85 MICRONS
THE 45°-LINE CUTS THE CURVES OF THE MESONS AND PROTON IN THE REGION OF THE SAME GRAIN DENSITY

The above result has an important bearing on the interpretation of the μ-decay process. Let us assume that it corresponds to the spontaneous decay of the heavier π-meson, in which the momentum of the μ-meson is equal and opposite to that of an emitted photon. For any assumed value of the mass of the μ-meson, we can calculate the energy of ejection of the particle from its observed range, and thus determine its momentum. The momentum, and hence the energy of the emitted photon, is thus defined; the mass of the π-meson follows from the relation

$$c^2m_\pi = c^2m_\mu + E_\mu + h\nu.$$

It can thus be shown that the ratio m_π/m_μ is less than 1·45 for any assumed value of m_μ in the range from 100 to 300 m_e, m_e being the mass of the electron (see Table 3). A similar result is obtained if it is assumed that a particle of low mass, such as an electron or a neutrino, is ejected in the opposite direction to the μ-meson.

TABLE 3

Assumed mass m_μ	E (MeV.)	$h\nu$ (MeV.)	m_π	m_π/m_μ ± 3 per cent
100 m	3·0	17	140 m_e	1·40
150	3·6	23	203	1·35
200	4·1	29	264	1·32
250	4·5	34	325	1·30
300	4·85	39	387	1·29

On the other hand, if it is assumed that the momentum balance in the μ-decay is obtained by the emission of a neutral particle of mass equal to the μ-meson mass, the calculated ratio is about 2·1 : 1.

Our preliminary measurements appear to indicate, therefore, that the emission of the secondary meson cannot be regarded as due to a spontaneous decay of the primary particle, in which the momentum balance is provided by a photon, or by a particle of small rest-mass. On the other hand, the results are consistent with the view that a neutral particle of approximately the same rest-mass as the μ-meson is emitted. A final conclusion may become possible when further examples of the μ-decay, giving favourable conditions for grain-counts, have been discovered.

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[1] *Nature*, **159**, 93, 186, 694 (1947).

NATURE PROTECTION IN GREAT BRITAIN

THE concept that Nature cannot look after itself and needs protection from the ravages of man in the interests of man is comparatively modern. The problem arose only when the increasing use of coal, the invention of steam power, and the consequent entry into the industrial age led to a large expansion of the population and its concentration into particular areas, as happened in Great Britain. The reservation of small tracts to prevent the extermination of rare plants is no novelty; in Switzerland certain plants, one being the edelweiss, have been protected in this way for a long time. The idea, however, that a whole region should be kept inviolate for all time from exploitation and development, for the benefit of the people, is comparatively recent.

The creation of what are called 'national parks' first happened in the United States of America. Some three-quarters of a century ago, a party of white explorers penetrating into what is now the Yellowstone National Park were so impressed with the stupendous grandeur of the scene that spontaneously and unanimously they decided that it ought to become the property of the nation. This expression of opinion was accepted by the Government, and by the Yellowstone Park Act of Congress of 1872 the first national park was established "as a pleasuring ground for the benefit and enjoyment of the people", to quote the Act. Thus was set in motion a movement which spread over not only the United States but also much of the civilized world. The largest of the national parks is the Kruger National Park in South Africa, and a notable one is the Albert National Park in the Belgian Congo.

The term used for these wild spaces has been criticized, because the work 'park' connotes an artificially laid out and maintained piece of land or a site for assembling vehicles, for example, artillery or automobiles. It is, however, useless at this late date to think of changing it, especially as an alternative, short of coining a new word, would be difficult, if not impossible, to suggest. There are two distinct and mutually incompatible concepts of the purpose of a national park. The first is the conservation of the scene and the wild life contained in it, which necessarily entails the restriction of human access. Obviously, vegetation cannot remain unimpaired if humanity in its thousands is allowed to roam over it, and to pluck flowers and uproot plants at will. In the Swiss National Park no one is allowed to stray from the high road except by permission or under guidance, and no interference with natural processes is tolerated; even fallen trees are allowed to decay in peace. The second concept is the use of the area as a public pleasure ground. In the enormous stretches of national parks in the United States and elsewhere the two concepts may easily be harmonized, for there is ample space for the accommodation and amusement of tourists without sensible encroachment upon the natural scene. Even so, warding is necessary, in order to ensure that tourists obey regulations and do no harm, especially by starting fires which may do extensive damage. The importance of a biological service to take advantage of the national park as a great natural laboratory for the study of plant and animal associations and of the relation to the character of the soil needs no stressing.

The creation of national parks in a small and densely populated country like Great Britain, and particularly England and Wales, is a very different problem. Here are no large virgin regions which may be declared public property without disturbance of private ownership or local administration, and national parks, from which the public would be largely excluded in the interest of the wild life there, are not feasible. On the other hand, Great Britain, though so small in extent, is favoured with beautiful landscape of a remarkably varied character, ranging from the grandeur of the Scottish Highlands and the Welsh mountains, the open expanse of the Yorkshire moors, and the contrasting combination of fell and water in the Lake District, to the rolling downs and smiling fields of the south. Such landscape is a great national asset and should be treated as such, and the establishment of national parks in this sense is highly desirable. The initiation of the movement to this end is due to the Council for the Preservation of Rural England, which in 1929 submitted a memorandum on the subject to the then Prime Minister. In consequence a Government committee under the chairmanship of Dr. Christopher (now Viscount) Addison was appointed to consider the desirability and feasibility of establishing national parks in Great Britain. The report[1], which favoured such establishment, appeared two years later; but unhappily the economic crisis supervened and nothing was done to implement its recommendations. The matter might, indeed, have passed into oblivion but for the action of the Council, which, in conjunction with the similar body for Wales, set up in 1935 the Standing Committee on National Parks, composed of representatives of the organisations that presented evidence to the Addison Committee. By means of questions in Parliament and in other ways the subject was kept alive. A debate was being planned in the House of Lords in the summer of 1939, when the imminence of war brought progress to a standstill.

The setback proved to be only temporary; planning was in the air, and the possible provision of national parks and Nature reserves could not be ignored in schemes for the use of the land. In the report[2] of the committee under the chairmanship of Lord Justice Scott the establishment of national parks and Nature reserves was recommended and, for the first time in an official document, the preservation of geological monuments was advocated. Under the auspices of the Society for the Promotion of Nature Reserves, a Conference on Nature Preservation in Post-War Reconstruction, composed of delegates representing national societies interested in the subject and organisations of local authorities, was convened in 1941, and reported[3] that, as regards national parks: (*a*) steps should be taken to implement generally the recommendations of the National Park Committee made in its report, and in particular to set up national park authorities, which would be responsible for matters of general policy, one for England and Wales and one for Scotland, with a joint committee to co-ordinate the working of the two; (*b*) the management and administration of areas comprised in national parks and Nature reserves should, so far as desirable, be undertaken locally, in which matter local authorities should play the leading part with the help of persons with special knowledge or interest; and (*c*) the facilities given to the public and students on Government properties should be considered and made part of a unified policy for the needs here discussed. As regards

Nature reserves, (*a*) the principle of establishing Nature reserves and sanctuaries should be accepted as part of the general national planning schemes; (*b*) an official body, representative of the scientific interests concerned, should be appointed to draw up detailed proposals; and (*c*) the management of reserves and sanctuaries should be placed only in the hands of persons fully conversant with the highly technical problems included in the maintenance of the balance of life, and the general control should be vested in a central authority, representative of the different interests concerned. At the same time, the Conference recommended the official recognition of what were afterwards known as conservation areas, which should be preserved in their present, unspoilt state. The Conference's short but valuable document has scarcely received the attention its importance deserves.

But the Conference did not stop there, and in 1942, in response to official request, appointed the Nature Reserves Investigation Committee. Without assistance from public funds and with the aid of only a small grant from the Pilgrim Trust, this Committee, despite the perils of those tragic years, carried out a comprehensive natural history survey of England and Wales. Though taken for granted at home, this work at such a time aroused wondering amazement abroad. It first issued a memorandum[4] on general principles, and then created an elaborate machine made up of twenty-four regional committees and a geological sub-committee. As the result of their investigations two memoranda were published: the first[5] on geological features and the second on wild life[6]. The separate regional reports were not published, but they were duplicated and thus made available to planning authorities and officers. Almost simultaneously a Committee of the British Ecological Society produced two reports[7].

A further stage was reached when Mr. John Dower, formerly drafting secretary of the Standing Committee on National Parks, was enlisted by the newly formed Ministry of Town and Country Planning to study the problem of national parks so far as it affected England and Wales. He submitted an elaborate and detailed report[8]. Its public welcome impelled the Ministry to delve still deeper into the complex questions involved, and to appoint a committee under the chairmanship of Sir Arthur Hobhouse for the purpose of considering the Dower Report, and making recommendations for the selection, delimitation, and administration of national parks, and for ancillary matters, including the conservation of wild life and the provision of footpaths and access to the countryside. The conservation of wild life was referred to a special committee, of which Dr. Julian Huxley was chairman and Prof. A. G. Tansley vice-chairman, and the other matter to another special committee under the chairmanship of Sir Arthur himself.

In the principal report[9] the desirability of national parks is accepted; but it is realized that their function will be more the spiritual and bodily refreshment of the people, especially the inhabitants of cities and towns, than the protection of wild life. The Committee recommends that their control should be entrusted to a National Park Commission, which would be responsible to the Minister of Town and Country Planning. Twelve areas are selected as national parks, to be created in three annual instalments. Of these, nine are in category *A* of the Dower Report, two are in category *B* and one is in category *C*; the last, the South Downs, is raised in status because of its proximity to London. Their management is to be handed to park committees, of which the chairman and one half of the other members would be appointed by the Commission and the other half by the local authorities concerned, an arrangement that may be expected to prove satisfactory provided that the two halves work in harmony and not in opposition. The main function of the Commission would be to control the development and use of the land of the national parks; conflict with Government departments is to be resolved by a permanent committee of the Cabinet created for the purpose. The setting up of a Coastal Planning Advisory Committee is recommended, and the need for national planning to resist coastal erosion is realized. The total capital cost is estimated to be £9,250,000, some of which, at least, would be suitable for grants from the Land Fund. In addition to the main areas the Minister is recommended to declare other similar, but smaller, tracts 'conservation areas', a term introduced by the Nature Reserves Investigation Committee, to be controlled by advisory committees. The total annual cost of all areas in Britain is estimated to be £170,000, rising eventually to £750,000.

The scope of the second report[10] covers more than the areas selected as national parks, since tracts of scientific interest whether for their wild life or for their geological features are not necessarily restricted to them. Frank and full acknowledgment is made of the value of the work of the Nature Reserves Investigation Committee, and the recommendations of the latter body for national Nature reserves and conservation areas and for geological features are adopted with but slight modifications. Reference is made also to the reports of the British Ecological Society mentioned above. Stress is laid upon the necessity for the proper maintenance of these natural features and the investigation of their scientific characters, and the establishment of a biological service for the purpose under the control, initially at least, of the Lord President of the Council, is recommended; specialists when needed would be seconded from the Geological Survey or the British Museum (Natural History). From the reference to the Society for the Promotion of Nature Reserves, it might be supposed that it depended for its income mainly on the endowment by the Hon. Charles Rothschild. Unhappily, at the present time that part of its income barely suffices to meet half the cost of maintaining the Nature reserve given by him and added to by his wife. The Society defrays its other activities almost entirely from the income from the far larger bequest made by Dr. G. Claridge Druce.

During recent years, distinct but complementary work has been carried on in Scotland. At the instance of the Association for the Preservation of Rural Scotland, the Scottish Council for National Parks was set up in 1943. The Scottish National Parks Survey Committee, with Sir J. Douglas Ramsay as chairman, was appointed in 1944, and in its report[11], which was issued soon after the Dower Report, various areas are recommended as national parks and various tracts as Nature reserves. The Scottish National Parks Committee under the same chairmanship was formed early in 1946 to study the detailed arrangements entailed by the previous proposals, and the Scottish Wild Life Conservation Committee, with Prof. James Ritchie as chairman, was appointed to advise it on the natural history aspect.

It is not unduly rash to say that a long way has been traversed towards the realization of the vision that inspired a few enlightened men and women eighteen years ago. Then it faded and all but vanished under the chill blast of the economic blizzard. Now that the vision once more seems on the point of taking shape, it has to face yet another such crisis. If a similar fate is not to befall it, the Government must be urged to appoint forthwith the National Parks Commission and at least the nucleus of the biological service. G. F. HERBERT SMITH

[1] The Report of the National Parks Committee. Cmd. 3851. (London H.M. Stationery Office, 1931.)

[2] Report of the Committee on Land Utilisation in Rural Areas. Cmd. 6378. (London: H.M. Stationery Office, 1942.)

[3] Memorandum No. 1. (London: Society for the Promotion of Nature Reserves, 1941; second edition, 1942.)

[4] Nature Conservation in Great Britain, No. 3. (London: Society for the Promotion of Nature Reserves, 1943; second edition, 1945.)

[5] National Geological Reserves in England and Wales, No. 5. (London: Society for the Promotion of Nature Reserves, 1945; second edition, 1946.)

[6] National Nature Reserves and Conservation Areas in England and Wales. No. 6. (London: Society for the Promotion of Nature Reserves, 1945.)

[7] Memorandum on Wild Life Conservation and Ecological Research from the National Standpoint; Nature Conservation and Nature Reserves. (London: Cambridge University Press, 1943.)

[8] National Parks in England and Wales. Cmd. 6628. (London: H.M. Stationery Office, 1945.)

[9] Ministry of Town and Country Planning. Report of the National Parks Committee (England and Wales). Cmd. 7121. Pp. ii+144. (London: H.M. Stationery Office, 1947.) 4*s.* 6*d.* net.

[10] Ministry of Town and Country Planning. Conservation of Nature in England and Wales. Report of the Wild-Life Conservation Special Committee (England and Wales). Pp. v+139. Cmd. 7122. (London: H.M. Stationery Office, 1947.) 4*s.* net.

[11] National Parks: a Scottish Survey. Cmd. 6631. (London: H.M. Stationery Office, 1945.)

OBITUARIES

Prof. E. Laqueur

THE death of Prof. Ernst Laqueur at the age of sixty-eight occurred on August 19, while he was on holiday in Switzerland.

Laqueur's death removes from the field one of the pioneers of modern endocrinology, and particularly that branch of it dealing with the sex hormones. Laqueur had had a very sound training in both chemistry and biological methods, and was himself also a qualified physician. This latter training gave him that great interest in the practical application of scientific work which undoubtedly acted as a stimulus for his investigations into the internal secretions.

His first major contribution to the subject of endocrinology occurred in the very early days of insulin. In the close of the year 1922, Banting and Best had published their classical paper demonstrating the presence of a stable anti-diabetic substance in the pancreas. From that moment biochemists all over the world concentrated on attempts to make possible the production, on an economic basis, of this new substance, insulin. Well in the forefront of this investigation was Prof. Laqueur with his team at Amsterdam. They made a large number of very important communications on both the preparation and the properties of insulin.

It was, however, mainly on the question of the sex hormones that Prof. Laqueur's reputation rests. It will be remembered that in 1924 Allen and Doisy started an entirely new epoch in research on the female sex hormone by applying the vaginal smear method of Stockard and Papanicolaou to the standardization of the ovarian hormone, as it was then called. Prof. Laqueur immediately started work on similar lines and was certainly in possession of one of the purest specimens of the hormone up to the time of the announcement by Aschheim and Zondek of the presence of the hormone in the urine of pregnancy. Again, this discovery completely changed the whole outlook on the biochemical research into the nature of the hormone; but again Prof. Laqueur was well in the forefront in the crystallization of the hormone from the new source.

In the early 1930's, Butenandt had succeeded in isolating a steroid substance from male urine. This substance, androsterone, proved to have the properties of the male sex hormone in that it was capable of causing growth of the capon's comb. Laqueur was the first to point out that an extract of the testis could be obtained which was more powerful, weight for weight, than the actual crystalline androsterone. At first Laqueur inclined to the view that there was some activator present in the testes and suggested the name of the '*X* substance'. Later, however, he characterized the actual hormone and named it 'testosterone'. This research was brought into line with the brilliant discoveries being made at Zurich in the laboratories of Prof. Ruzicka. He had shown that by oxidizing away the side-chain of sterols such as cholesterol, it was possible to obtain the cyclopenteno-phenanthrene nucleus with the right stereochemical configuration, and that this could be used as a basis for the partial synthesis of sex hormones. Testosterone is produced by this method. We have, therefore, in this brilliant research of Prof. Laqueur an excellent example in which skilful and penetrating biological observational work can be combined with organic chemistry, leading to the isolation, characterization and large-scale production of new compounds.

Prof. Laqueur was a frequent visitor to Britain and was well known to all those who worked in this field through his assistance at the various international congresses before the War. With the invasion of Holland by the Germans he was removed from his post, and both he and his family were subjected to the cruellest of treatment. He emerged from the War with severely impaired health, but those who saw him after his ordeal commented on his completely unbroken spirit.

Holland and the science of endocrinology have lost a great pioneer. E. C. DODDS

Prof. Ll. Rodwell Jones

BY the death on August 15 of Ll. Rodwell Jones, shortly before his sixty-sixth birthday, British geography has lost one of its rapidly dwindling group of 'elder statesmen'.

Rodwell Jones was born on August 28, 1881. In due course he proceeded from Kingswood School, Bath, to the University of London, where he took a science degree, and then commenced school-teaching. It was while so engaged that he came under the stimulating influence of Mackinder, then at the London School of Economics, and found his vocation in geography. An appointment as lecturer in geography in the University of Leeds in 1913 was all too soon interrupted by the First World War, in which he served in the West Yorkshire Regiment, reached the rank of major and was decorated with the Military Cross. Shortly after his release from the army he returned to London to join Mackinder's staff at the London School of Economics, and in 1925 succeeded him as professor of geography and co-head of the King's College, London School of Economics Joint School of Geography. He had planned to retire on reaching the age of sixty, but the Second World War necessitated an unwelcome postponement, and it was not until 1945 that he felt justified in vacating his post.

It is difficult to assess with any confidence the relative value of Rodwell Jones's contributions to his subject. His output of published work was limited both by his devotion to the needs and interests of his very large department and by his extremely exacting standards of scholarship. He committed nothing to print until he had tested and re-tested materials and methods, and satisfied himself of the soundness of his conclusions. His major works, "Northern England", "North America" (in collaboration with Dr. P. W. Bryan), and "The Geography of London River" are, in consequence, not merely interpretations of first-class importance, but models of method as well. Yet it is as class teacher and research adviser that he will probably be most vividly and gratefully remembered by his students. Shy in nature, and lacking the platform brilliance of a Mackinder or a Lyde, he gained the respect, admiration and enduring affection of successive generations of students, who experienced at close range the humour and the kindliness behind his shyness, and were helped to acquire permanent habits of critical and constructive thinking in their subject.

NEWS and VIEWS

International Control of Atomic Energy

SIR CHARLES DARWIN opened a discussion on "Atomic Energy and the Veto" which formed part of the programme of a meeting of the Atomic Scientists' Association held at Oxford on September 20. He said he wanted to examine carefully the grounds on which a case might be built for treating atomic energy in a different way from other armaments, in the setting up of the proposed Atomic Development Administration and in its freedom from the veto. This he analysed coldly under seven headings: (1) pure military, (2) novelty, (3) mass destruction, (4) start of war, (5) treachery, (6) scale effect and (7) feasibility. Under the first three headings he found no reason for special treatment; but under the last three he found there is a definite case. The strongest argument is the unanimous report of the Atomic Energy Technical Committee of the United Nations Organisation that international control is, in fact, a workable proposition from a technical point of view. Sir Charles discussed the seven headings in some detail. In relation to (1), he said he thought that the atomic bomb is not a 'good weapon'. Although it would certainly be effective for use on naval bases, he did not believe it would be used for land warfare. In relation to (4), he said that although the bomb could deliver a tremendous blow, it could not prevent retaliation in kind, which he thought might act as a severe deterrent to its use. With regard to (5), he stressed the possible use of the bomb as a secret weapon of treachery by an unidentifiable third party in a dispute.

Prof. N. F. Mott, in thanking Sir Charles Darwin, said he thought there might be a case for 'de-bunking' the atomic bomb, but wondered whether Sir Charles had not 'de-bunked' it too much. Dr. W. J. Arrol stressed the importance from a purely military point of view of attacks on ports and convoys. The extreme danger of its use for attack on industry and for mass-destruction was implicit in the remarks of most of the speakers. Captain Blackburn, M.P., for example, said that the scientific men had done their job in showing that atomic control is technically feasible, and that the problem is now a political one. Control is being frustrated, he said, by the U.S.S.R., and he advocated an urgent meeting of Mr. Attlee and Mr. Truman with Mr. Stalin to put the danger to the latter in the plainest terms. Failing agreement, peace-loving nations must develop predominance in atomic and other power. Mr. Conybeare did not agree that the U.S.S.R. is frustrating control, and Dr. H. W. B. Skinner said that, while agreeing with most of Captain Blackburn's remarks, he deprecated the atmosphere of crisis. Dr. A. T. Waterman, a guest from the United States, stressed the value of international co-operation in science. Dr. K. Lonsdale asked whether there would be any purpose in the Association of Atomic Scientists calling on scientific workers not to take part in the manufacture of atomic weapons; but Prof. Mott thought that it would not be possible to secure a majority opinion on this suggestion. Another speaker complained of the placidity of the discussion of a situation in which we were running into another war, and there was some argument as to the future aim of the Association, Mr. Freedman, in particular, feeling a lack of guidance in the present dangerous situation. But Prof. R. E. Peierls said that, though scientific men should not be afraid of politics, policy must be clear-cut and united. Urgency does not replace judgment, and he felt that, at present, no straightforward lead could be given. The functions of the Association must therefore remain for the moment mainly educational.

Electron Jubilee Exhibition

To mark the fiftieth anniversary of the discovery of the electron, an exhibition, illustrating the scientific and industrial developments and the numerous electronic devices resulting from that discovery, is being held at the Science Museum, London. The exhibition is arranged around one gallery of the Museum, and is divided into eight sections, each of which is devoted to one particular aspect of the subject. By photographs, diagrams (some of which are animated), working exhibits, and the display of historical and modern apparatus, the visitor is shown how the wave-like and particle-like properties of the electron were discovered, and is given an appreciation of the way in which these discoveries have opened up a new era, both in science and industry.

An attractive handbook to the Exhibition, with an intriguing cover and a photograph of Sir J. J. Thomson, the discoverer of the electron, as frontispiece, has been prepared by Mr. D. H. Follett (Institute of Physics, London. 1*s.* 2*d.* post paid). It is in two parts. The first is a guide to the exhibition and lists the exhibits in the eight sections in the order in which they are displayed. The second is a descriptive account of the background to the several exhibits. It is well written, and the reader with some knowledge of physics will find that it gives an accurate summary of the history of the electron during the past fifty years. The subjects dealt with include: the discovery of the electron and the measurement of its charge; the thermionic valve and the cathode ray tube; the photo-electric effect and devices; atomic structure; electron diffraction; X-rays; and the conduction of electrons in gases and solids. It is a pity that no illustrations of the actual exhibits are given. Doubtless a third part to the handbook, similar to that produced for the 'low-temperature' exhibition several years ago, with photographs of the exhibits and exhibition, would receive a welcome. The exhibition will remain open to the public for three months.

Automatic Control on Atlantic Flight

A U.S. Air Force "Skymaster" transport aircraft flew from Stephenville, Newfoundland, to Brize Norton R.A.F. Station in Oxfordshire, on September 22, a distance of 2,400 miles across the Atlantic, including taking off and landing, without being controlled in any way by the crew on board. The machine was commanded by Colonel J. N. Gillespie of the U.S. Air Force, and carried a number of scientific observers as well as the normal crew. The apparatus automatically controls the take-off and climb to an arranged height. It then homes on a beam sent out by a radio beacon. In this case these came from two successive ships on the way across, and then from Brize Norton. Finally, it sets the machine into the required glide, lands and brakes. In the United States the system is understandably described as 'push button flying'.

The real significance of this system lies in the ability to make landings at the end of the flight. Automatic control of direction during a flight has been in use successfully for some time. A flight can now be commenced without fear as to what the weather conditions will be at the end of it. The radio control is independent of the weather and can land a machine under conditions in which human control would be impossible; in bad visibility, for example. The apparatus is such that it can be fitted to any aircraft of sufficient capacity; in fact, the machine which has just crossed the Atlantic was a standard Skymaster of the U.S. Air Force. The system would not be applicable to bombing raids, as it depends upon radio co-operation from the terminal point, which would not be available from the enemy territory.

Correspondence of Isaac Newton

ALTHOUGH Isaac Newton is acclaimed as the greatest leader of scientific thought that the world has known, there exists no satisfactory collected edition of his works. The Council of the Royal Society has decided to make a first step in the arduous undertaking of preparing such an edition by producing in a worthy form the collected correspondence of Newton, which will comprise letters written by him and the replies to them. Prof. H. W. Turnbull has undertaken the editorship of this work. The Council of the Royal Society has entrusted the immediate organisation of the publication of the Newton correspondence to a sub-committee of the Society, under the chairmanship of Prof. E. N. da C. Andrade. It is hoped that learned institutions, museums, libraries and collections will collaborate in the work, by notifying the assistant secretary of the Royal Society of any letters of Newtonian interest that they may possess, and by lending the letters to the Society for a brief period or by arranging with the Society for photographic copies to be made.

Overseas Broadcast of the British Association Meeting

A SERIOUS attempt was made by the B.B.C. to give listeners an account of the recent meeting of the British Association in Dundee, by bringing representative speakers to the microphone every day. A descriptive broadcast on Dundee and St. Andrews was also given in the B.B.C. overseas service to Germany on September 19, and repeated on September 23. The broadcast, recorded in German, included an account of the Dundee shipyards and of visits to marmalade and jute factories. There were also interviews at Dundee with Prof. J. D. Cockcroft on atomic energy, Sir Robert Watson-Watt on radar and Dr. E. B. Chain on penicillin. The account of the University of St. Andrews and of the ancient buildings of the city included interviews with Dr. C. T. Carr, lecturer in German, and Dr. John Read, professor of chemistry, whose reference to alchemical music was illustrated by a gramophone reproduction of one of Count Michael Maier's canons from "Atalanta Fugiens" (1618).

Heredity

RECENTLY there has appeared the first number of the new journal, *Heredity*, devoted, as its name indicates, to genetics (*Nature*, **159**, 599; 1947). In the past fifty years, this science has seen an expanding flow of publications—a flow which the War did little to check. Before 1939 this increase was matched by the increasing number of journals which offered facilities for the publication of findings in genetics; but far from the increase in means of publication continuing, the War has led to a reduction in the number of genetics journals in Europe. The appearance of a new one is therefore particularly welcome at the present time. *Heredity* is jointly edited by Dr. C. D. Darlington and Prof. R. A. Fisher, and it is published by Messrs. Oliver and Boyd of London and Edinburgh. Its international nature is emphasized by the board of five collaborating editors, of whom three are from Europe and two from the United States. The editorial policy is a liberal one both in the types of articles which will be accepted and in the fields from which they will be drawn. Historical, review and critical contributions will find their places beside the records of new research; and cytology, statistics, biochemistry, evolutionary theory and breeding work will all be accepted in so far as they are related to genetics. The new journal is to appear three times a year.

The first number of *Heredity* well illustrates how this editorial policy is put into practice. It contains ten articles, covering a wide field in their nature, in their subject-matter and in the countries from which they originate. The first two form a novel departure and one which should do much towards overcoming the consequences of difficulty in communication during the war years. These are, respectively, a summary of genetical research in Great Britain during 1939–45, and a bibliography of German and Italian research during the same period. Though running to some six hundred titles, this list is not complete in its German section, and a supplementary bibliography is promised. Two short papers describe a new gene and a new linkage in the mouse, and a third is devoted to the colour inheritance and sex-determination in the fish, *Lebistes*. From the plant side come two papers: one on the interaction of self-incompatibility genes when, contrary to their usual situation, two are present in the same pollen grain; and one on the theory of breeding plants for increased yield. Two further papers consider the effects of natural selection, in one as exemplified by change with time in frequency of certain chromosome types in *Drosophila*, and in the other by the change with climate in frequency of a gene causing a waxy bloom in *Ricinus*. Finally, there is a statistical discussion of the measurement and analysis of virulence in bacteria and viruses, as it might be applied to genetical work.

International Union of Biological Sciences

This Union held its first post-war meeting at Copenhagen at the end of July. It was attended by delegates from the various sections and from seventeen countries. Dr. Joseph Needham attended the meeting on behalf of the United Nations Educational, Scientific and Cultural Organisation, and Prof. Borel and M. Establier on behalf of the International Council of Scientific Unions. It was agreed to form new sections of experimental cytology, embryology, genetics, microbiology and zoology. In addition to the Joint Commission on Oceanography on which the Union is represented, it was agreed to form certain new committees on border-line subjects and to invite other unions to nominate members: the subjects agreed upon were radiobiology and natural calamities. A long list of congresses and symposia were notified for the year 1948. Proposals were discussed for the publication of a catalogue of type-specimens of animal species and of historic collections, for the distribution of artificial radioactive isotopes for biological experiments and for the creation of a centre for marine biology in the Malay Archipelago. A resolution was adopted urging that all possible means be taken to prevent biological warfare. It was agreed to hold the next meeting in 1950, probably in Stockholm. The following officers were elected: *President*, Dr. M. J. Sirks (Netherlands); *Vice-President*, Prof. H. Munro Fox (Great Britain); *General Secretary*, Prof. P. Vayssière (France); *Secretary*, Prof. Stuart Mudd (United States); and *Treasurer*, Prof. Chodat (Switzerland).

Chemistry and Uses of Fluorine

A whole number of *Industrial and Engineering Chemistry* (39, 236–435; March 1947) is devoted to the chemistry of fluorine and its compounds. The production of fluorine on the industrial scale and its storage and utilization are fully described. The common electrolytes are fused acid potassium fluorides with carbon anodes, and up to 2,000 amperes were used in the electrolysing currents. An anode current efficiency of about 95 per cent was attained. Small laboratory units are also dealt with. The gas can be piped in steel or copper, and compressed up to 400 lb./in.^{2} in nickel and steel cylinders. Purification reached 98 per cent minimum. Fluorination of hydrocarbons formed numerous products up to $C_{18}F_{30}$, and in this work much use was made of cobalt trifluoride, CoF_3, and silver difluoride, AgF_2, and reactions in liquid hydrogen fluoride. A novelty is the fluorine-hydrogen blowpipe, used for welding metals. The papers represent a notable advance in fluorine chemistry.

Archæological Work in China

Occasional Papers (vol. 1, No. 1) of the Freer Gallery of Art (Smithsonian Institution) is devoted to a description of the tomb of the Grand Empress Dowager Wên Ming and the Northern Wei necropolis at Fang Shan. The author (A. G. Wenley) has produced an interesting little work of some 28 pages with six full-page photographs of the site. It starts with a short account of the Empress Dowager herself, followed by a description of the necropolis and tomb where she is buried. The work itself is dedicated to the late Carl Whiting Bishop, who was associated with the Freer Gallery for twenty years and who was much interested in certain Northern Wei dynasty imperial mausolea.

German Food Industry in War-time

An exhibition of photographs, drawings and specimens obtained in Germany by British Intelligence Objectives Sub-Committee investigating teams sponsored by the Ministry of Food will be on view in the Conference Hall, Portman Court, Portman Square, W.1, during October 15–29 each day from 10 a.m. to 4 p.m. Informal talks will be given in the exhibition at 3 p.m. on German soapless detergents (Mr. G. R. Perdue, British Launderers' Research Association); developments in the German dairying industry (Mr. F. C. White, Ministry of Food); war-time production of food yeast in Germany (Mr. H. J. Bunker, Barclay Perkins and Co., Ltd.); food preservation and refrigeration in Germany (Dr. E. C. Bate-Smith, Department of Scientific and Industrial Research).

University of London: Appointments

The following appointments in the University of London have been announced: Mr. M. McGregor Cooper, senior lecturer in dairy husbandry at Massey Agricultural College, New Zealand, to the University chair of agriculture tenable at Wye College; Prof. W. J. Hamilton, since 1945 regius professor of anatomy in the University of Glasgow, to the University chair of anatomy tenable at Charing Cross Hospital Medical School; Prof. W. G. Holford, since 1931 Lever professor of civic design in the University of Liverpool, to the University chair of town planning tenable at University College; Dr. W. A. Lewis, lecturer in commerce at the London School of Economics and also principal in the Board of Trade and in the Colonial Office, to the University readership in Colonial economics tenable at the School.

The title of reader in mining geology in the University has been conferred on Dr. David Williams, in respect of the post held by him at the Imperial College of Science and Technology.

Announcements

The sixth Hinchley Memorial Lecture of the Institution of Chemical Engineers will be delivered by Dr. R. V. Southwell, rector of the Imperial College of Science and Technology, on October 14 at 5.30 p.m. at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. Dr. Southwell will speak on "Relaxation Methods: a Method for the Engineer".

Dr. E. Ashworth Underwood, director of the Wellcome Historical Medical Museum and honorary lecturer in the University of London (University College), has been awarded the Cross of the Chevalier of the Legion of Honour.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mode of Action of 'Paludrine'

INVESTIGATING the activity of 'Paludrine' against plasmodia in tissue culture, Tonkin[1] and Hawking[2] concluded that the drug was inactive *in vitro*, but was metabolized to an active form in the serum of the host. In view of these observations, it surprised us to find that 'Paludrine' inhibited the oxidation of glucose, pyruvate and lactate by washed chick red cells parasitized with *P. gallinaceum* more powerfully than did quinine (Table 1).

TABLE 1

Inhibitor	Conc.	% inhibition of oxygen uptake after 2 hours		
		Glucose	Pyruvate	Lactate
'Paludrine' HCl	1/300,000	4·6	Nil	Nil
	1/60,000	20·7	2·5	24·1
	1/6,000	84·5	84·0	89·4
Quinine HCl	1/60,000	10·4	5·6	5·5
	1/6,000	15·8	15·6	5·5

Determinations of glucose utilization and changes in phosphorylated intermediates in parasitized red cell incubates in the presence of 'Paludrine' and of iodoacetic acid showed that 'Paludrine' inhibition was essentially different from that of the iodoacetate (Table 2). While the latter inhibited both oxygen consumption and glycolysis, with accumulation of hexose phosphates, 'Paludrine' showed less than 50 per cent inhibition of glucose utilization, although oxygen consumption was inhibited to a greater extent. Similar observations on quinine indicated that it inhibited glycolysis rather more strongly than oxidations, probably by inhibiting the hexokinase reaction[3].

TABLE 2

	Inhibitor	Conc.	μ Mols used up (−) or formed (+) per hour per 100 μ mols glucose used by controls							
			Glucose	A.T.P.	Glucose-6-phos.	Fructose-6-phos.	Phospho-glyceric acid	Pyruvic acid	Lactic acid	Oxygen
Expt. 1	Control	—	−100	−141	−23·8		+91·3	+17·5	+625	−266
	'Paludrine' HCl	1/6,000	−69	−74	−31·3		+26·2	+13·8	+313	−31
	Iodoacetic acid	1/6,000	−11	−55	−7·4		+51·0	+2·9	+31	−58
Expt. 2	Control	—	−100	−66	−3·5	+0·7	−3·4	+3·0	−118	−71
	'Paludrine' HCl	1/3,000	−54	−26	−2·6	+1·0	+0·5	+4·3	−187	−5
	Iodoacetic acid	1/3,000	−13	−97	+8·9	+2·6	−3·1	+0·7	−414	−12

These observations suggest that 'Paludrine' exerts its anti-malarial action, at least partially, by inhibiting the oxidation processes in the parasites, but does not directly effect the anaerobic breakdown of glucose to lactic acid. However, higher concentrations of 'Paludrine' than those used by Tonkin and Hawking were necessary, particularly in the phosphorylation experiments, in order to produce measurable changes, and in the comparative experiments with quinine the greater inhibitory action of 'Paludrine' was more marked at high than at low concentration. It may be, therefore, that inhibition of oxidative processes does not play such an important part where 'therapeutic' concentrations of the drug are concerned.

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Aug. 1.

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[1] Tonkin, I. M., *Brit. J. Pharm.*, **1**, 163 (1946).

[2] Hawking, F., *Nature*, **159**, 409 (1947).

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β-Glucuronidase and Tissue Damage

AFTER repeated feeding of menthol to mice, Fishman[1] obtained results which on statistical examination showed an increase in β-glucuronidase in liver, spleen and kidney as compared with organs from untreated animals. Similar results were obtained in dogs fed with borneol. Since the compounds examined are known to be excreted as the glucuronides in certain species, Fishman considered β-glucuronidase to be responsible for glucuronide synthesis *in vivo*, and that he was measuring adaptation on the part of the enzyme in response to the presence of excess substrate. The work of other authors is not, however, compatible with the view that the function of β-glucuronidase in the body is other than hydrolytic[2,3,4].

Using biosynthetic phenol β-*d*-glucuronide[5] for the assay of glucuronidase[6], an attempt was made to confirm Fishman's findings with menthol. Twenty-four hours after intraperitoneal injection of *l*-menthol in vegetable oil into mice there was a marked rise in glucuronidase in liver, but not in kidney. It was difficult to decide whether the spleen enzyme was affected because of the great variation in normal values observed with this organ. Average normal values were the same in the case of each organ for mice of both sexes and drawn from three different colonies. The rise in liver glucuronidase was less marked after repeated feeding of menthol than after injection of much smaller doses.

It was observed that menthol caused gross damage to the liver, but not to the kidneys, and it was considered that this property, rather than the one of giving rise to a glucuronide, might explain the effect on liver glucuronidase. A variety of other substances, known to cause damage to the liver or kidneys, but with one exception unlikely to form glucuronides, were therefore examined for their effects on glucuronidase. Compounds which are relatively non-toxic, but which are known or considered to form glucuronides in the body, were also examined. The substances were injected subcutaneously or intraperitoneally in oil or aqueous solution into groups of 3–9 mice, and the animals were killed after 1–3 days. With several of the substances, the organs were examined histologically

Substance	Dose gm./kgm.	G.U.*/gm. moist tissue			Histological findings
		Spleen	Liver	Kidney	
Normal mice	—	580	280	378	—
Liver poisons					
l-Menthol	0·33	777	933	285	Moderate fatty degeneration and necrosis of liver, with evidence of repair, all most marked with carbon tetrachloride. Little deviation from normal in kidney and spleen.
l-Menthol β-*d*-glucuronide	2·3	995	1104	295	
Carbon tetrachloride	5·33	840	1138	139	
Chloroform	2·0	1079	939	194	Not done.
Kidney poison					
Mercuric nitrate	0·02 to 0·04	718	469	808	Kidney was profoundly damaged, with marked necrosis in the medullary region and hyaline casts. Liver and spleen showed little change from normal.
Liver and kidney poisons					
Yellow phosphorus	0·0075	506	91	338	Marked fatty degeneration of liver with no signs of repair. Small areas of necrosis in kidney, most marked in cortex. Spleen as normal.
Phenyl arsenoxide†	0·001 to 0·002	807	257	471	Extensive fatty changes in liver with severe necrosis and no evidence of repair. Kidney as with phosphorus, but changes more obvious. Spleen as normal.
'Non-toxic' compounds					
Sulphathiazole	43	561	460	368	Not done
Pregnanediol‡	0·33	1001	287	321	
Pregnanediol‡ β-*d*-glucuronide	0·80	627	241	264	

* One G.U. (glucuronidase unit) liberates 1 μgm. phenol from 0·015*M* phenol glucuronide at 38° and *p*H 5·2.
† This compound could conceivably give rise to a glucuronide.
‡ Injected as a suspension in oil.

by Mr. J. G. Campbell of the Royal (Dick) Veterinary College, Edinburgh. As shown by the averaged results in the table above, a significant rise in the β-glucuronidase level only occurred when an organ showed obvious, but not irreparable, damage.

Phenylarsenoxide had no effect on the glucuronidase level in liver or kidney, while phosphorus actually depressed it in the case of liver. Both substances, however, caused extensive damage. These results favour the view that a rise in glucuronidase is associated with tissue regeneration following moderate damage rather than with the damage itself. A series of experiments is in progress to settle this point. The effects observed with menthol glucuronide were presumably due to liberation of menthol by glucuronidase initially present in the body, and are difficult to reconcile with Fishman's views. The rise in liver glucuronidase caused by carbon tetrachloride may to some extent explain its enhancing action on the effect of œstrogens[7], since glucuronide formation plays some part in the metabolism of the latter compounds. It is interesting to note that both carbon tetrachloride[8] and chloroform[9] are known to produce hepatomata after repeated administration to mice. The possibility of menthol behaving similarly is under investigation. In a recent communication to *Science*, Fishman[10] gives figures showing that in some cases of human carcinoma the tumour contained much more glucuronidase than the corresponding normal tissue. He suggests that this may be due to excessive local accumulation of œstrogens. In view of the bearing of our results on this finding, it was considered that an interim account should be published without further delay.

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The Sulphatase of Clarase

'CLARASE'*, an enzymatic preparation containing mainly amylase and in smaller amounts maltase, protease, peptidase, lipase and other enzymes, has now been shown to possess sulphatase activity. This sulphatase appears to be mainly phenolsulphatase. Other sulphatases (glucosulphatase[1], chondrosulphatase[2] and myrosisnase[3]) from various sources have been described by different authors.

Conditions for the activity of sulphatase of 'Clarase' were examined; the optimum *p*H was found to be about 6.

Of the buffers used the $M/7 \cdot 5$ phosphate was found to be most suitable. A slight inhibition was observed with acetate buffer and a very marked one with B.D.H. universal buffer.

The sulphatase of 'Clarase' hydrolyses the ethereal sulphates of horse urine, but not to such an extent as the takadiastase described by Noguchi[4]. Under comparable conditions only 24 per cent of the ethereal sulphates were hydrolysed as against 93 per cent reported by Noguchi. Contrary to the opinion of Noguchi, who ascribes the high percentage of hydrolysis to favourable conditions prevailing in horse urine, it was found that the sulphatase of 'Clarase' is actually inhibited by that medium, as is shown in the accompanying table:

INHIBITION OF SULPHATASE BY HORSE URINE

(Percentage hydrolyses of the ethereal sulphates of horse urine compared with those of potassium phenylsulphate in phosphate buffer; the concentrations of substrates expressed as SO_3 are equal.)

	Control		2% 'Clarase'		4% 'Clarase'	
Time (days)	Horse urine	Phosphate buffer	Horse urine	Phosphate buffer	Horse urine	Phosphate buffer
1	0·6	0·8	20·0	53·2	41·2	72·0
3	1·2	2·6	23·4	55·4	44·4	84·9
5	1·4	3·2	24·4	60·2	47·0	93·0

(The chief ethereal sulphates found in horse urine besides potassium phenylsulphate, namely, indican and potassium-tolylsulphate, were shown to be hydrolysed by the sulphatase of takadiastase to approximately the same extent[5,6].)

Human urine was also proved to exert an inhibitory effect on the sulphatase of 'Clarase', though to a lesser degree.

It is possible that urea is the substance partially responsible for the inhibition by both horse and human urine, as in pure buffer solution it inhibits the activity of sulphatase; the degree of inhibition is dependent on the concentration of urea.

* Produced by Takamine Laboratory, Inc., Clifton, N.J.

When potassium phenylsulphate, which was used as substrate in the above experiments, is replaced by potassium dimethyl-phenylsulphate, a reduction in the rate of hydrolysis is observed. Hence introduction of aliphatic radicals into the benzene ring of potassium phenylsulphate seems to hinder the activity of the enzyme. This effect is still more marked when carvacryl (2-methyl-5-isopropyl) sulphate is used as substrate.

A fuller account of these investigations will be published shortly.

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Fructose and the Reducing Value of Insects' Blood

THE reducing value of the blood or hæmolymph of insects is a very variable quantity, depending both on species and on the stage of the life-history[1,2]. However, all observations agree that the true blood sugar accounts for only a fraction, usually considerably less than 30 per cent, of the total reducing value. On the grounds that this fraction is yeast fermentable, and that in a few cases a glucosazone has been obtained, this sugar has been considered as glucose[2-4].

The total reducing value of the hæmolymph of the 3rd instar larva of the fly *Gastrophilus intestinalis*, parasitic in the stomach of the horse, averages 356 mgm. per cent, calculated as glucose; of this value the high figure of some 200 mgm. per cent or 60 per cent is fermentable by yeast and constitutes the reducing blood sugar. Previous workers[5,6] have suggested that glucose is present in the hæmolymph; but in view of the following evidence, the whole of the fermentable sugar may be accounted for by the content of fructose.

The deproteinized hæmolymph gives a strongly positive resorcinol (Seliwanoff) reaction and the glucosazone was isolated. Following the advice of Dr. D. J. Bell[7], the β-diacetone fructose compound was crystallized from a pooled blood sample. The melting point (uncorrected) was 94·5° C., while the mixed melting point obtained with a sample prepared from pure fructose was 94·2° C. Employing the quantitative method of Roe[8], I have found the fructose content of the blood to vary from 184 to 294 mgm. per cent.

If a blood sample be allowed to stand, fructolysis occurs spontaneously. In a blood sample allowed to stand for two hours at 37° C. the fructose content decreased by 14 per cent, while the blood lactic acid increased by 48 per cent. The fructose is almost entirely in the free, that is, non-phosphorylated state.

Adapting the Roe method for a qualitative as well as a quantitative test, no appreciable amounts of fructose were found in the blood of the adult locust (*Schistocerca* sp.), the larva of the wax moth (*Galleria mellonella*), or in the late third instar larva or adult of the blow-fly (*Calliphora erythrocephala*). Values found for the two stages of the latter species were 14 mgm. per cent and 5 mgm. per cent respectively.

Just prior to the onset of pupation, the reducing value of *Gastrophilus* blood rapidly increases to more than 500 mgm. per cent, although the fructose remains at its normal level. As pupation advances, the fructose content rapidly decreases, as shown in the following table:

Age of pupa, in days	1–2 (pre-pupa)	2–3	6–7	10–11
Total reducing value in mgm. %	375	196·5	186	202·5
Fructose content in mgm. %	171·2	100·5	31·6	21·7

Yeast fermentation tests have demonstrated that the whole of the fermentable sugar is still fructose, and that, therefore, by the tenth day of pupation, when the developing fly is externally almost fully formed, glucose has not increased at the expense of fructose.

It should be pointed out that these experiments were performed from March onwards, when the *Gastrophilus* larva is accumulating large stores of fat, and its glycogen reserves are being depleted[5,9]. The possible role of fructose in the intermediary metabolism of this change is to form the subject of further work.

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Aug. 12.

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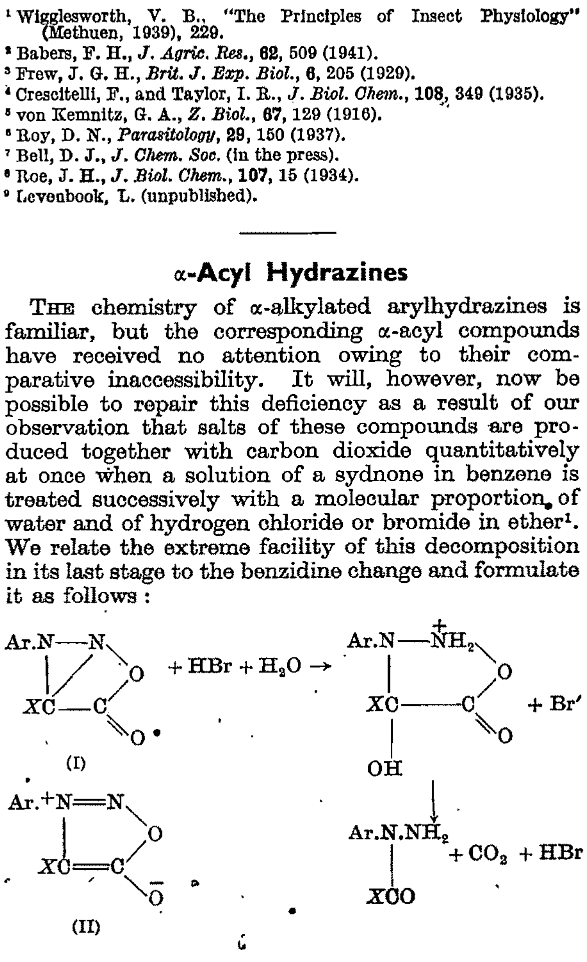
α-Acyl Hydrazines

THE chemistry of α-alkylated arylhydrazines is familiar, but the corresponding α-acyl compounds have received no attention owing to their comparative inaccessibility. It will, however, now be possible to repair this deficiency as a result of our observation that salts of these compounds are produced together with carbon dioxide quantitatively at once when a solution of a sydnone in benzene is treated successively with a molecular proportion of water and of hydrogen chloride or bromide in ether[1]. We relate the extreme facility of this decomposition in its last stage to the benzidine change and formulate it as follows:



It would appear very difficult to interpret these facts in terms of the formula (II) considered in earlier correspondence[2], although this latter accords with other evidence and with the immediate reduction of potassium permanganate in acetone. On the other hand, we have not observed phenolic reactivity of N-phenyl sydnone towards aldehydes or coupling agents, and we conclude that the sydnones exhibit intra-annular tautomerism between structures I and II.

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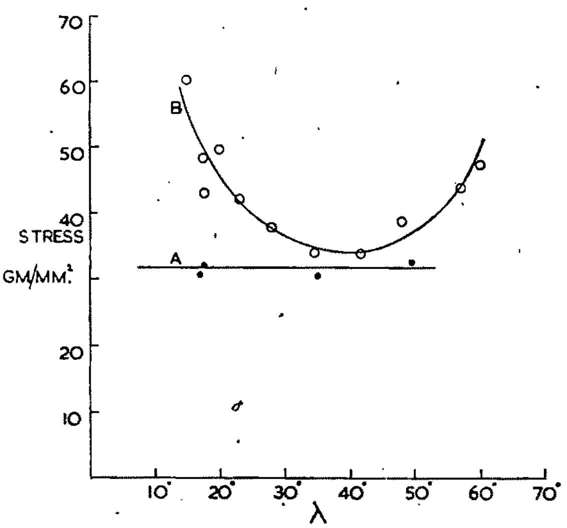
Thermal Hardening of Cadmium Crystals

THE phenomenon of thermal hardening was first observed by Orowan[1,2] in single crystals of chemically pure zinc. He noticed that, sometimes, zinc crystals, after resting for 24–48 hours at room temperature, showed no trace of plastic deformation with applied stresses as much as 30 per cent above the previously determined critical yield stress. The crystal might remain for several minutes under such a high load without yielding; then extension would suddenly occur, and the yield stress fall, almost immediately, to the normal value originally observed.

Recent work in this Laboratory with single crystals made from spectroscopically pure cadmium has shown that the phenomenon is not a rare one, but occurs with every crystal used. These cadmium crystals show appreciable hardening (increase of yield stress by 5 per cent over the previously determined yield stress) in times as short as 4–5 min. at room temperature. Preliminary experiments showed that, for the temperature range 20–100° C., the time of annealing necessary to produce a given degree of thermal hardening decreases by a factor of between 2 and 3 for every 10° C. rise in temperature, and even with those crystals slowest to harden (see below) the process was always complete after annealing at 200° C. for 30 min. After this treatment the yield stress had been raised to a limiting maximum value, and this was therefore adopted as standard treatment in later experiments.

Two other factors were also found to influence markedly the rate of thermal hardening, namely, orientation and pre-straining of the crystal. The period of annealing was found to be a maximum for crystals where λ (the angle between the direction of the applied stress and the glide direction) lay between 30° and 50°. These figures could not be determined very accurately. The period of annealing was also found to increase rapidly with the amount of pre-strain impressed on the crystal, as is shown by the following figures. The 'hardening time' is the time needed, at room temperature, for the yield stress to rise 5 per cent above the previously determined critical shear stress.

Hardening time	Pre-strain
5 min.	0·1 per cent
40 ,,	3·8 ,,
140 ,,	11·0 ,,



After this preliminary work, further experiments were performed to determine how the value of the 'raised' yield stress varied with the orientation of the crystal, the annealing conditions being constant, that is, 200° C. for 30 min., and then cooling to room temperature, at which temperature the yield stress was determined.

The accompanying graph shows the variation, with orientation, of both the normal yield stress in shear (curve *A*), and also the 'raised' yield stress (curve *B*), for spectroscopically pure cadmium (99·999 per cent Hilger H.S. specification). As is to be expected, the normal yield stress is constant at 32 ± 1 gm./per mm.^{2}. The yield stress has also been determined for 'chemically pure' cadmium and found to be 60 ± 1 gm./mm.^{2}. These results are in good agreement with those of Andrade and Roscoe[3], who give corresponding values of 26 gm./mm.^{2} and 56 gm./mm.^{2}. The effect of very small amounts of impurity on the value of the critical shear stress has also been reported by Dehlinger and Gisen[4], who found that, in changing from 99·87 to 99·98 per cent aluminium, the yield stress falls from 145 gm./mm.^{3} to 85 gm./mm.^{2}.

The curves also show the striking fact that the magnitude of the thermal hardening is a minimum for crystals with the glide direction at an angle λ between 40° and 45° to the axis of the wire, and that with these crystals it is approximately zero. For angles of orientation on each side of the minimum, the 'raised' yield stress rises rapidly, the maximum so far observed being approximately 70 per cent above the normal value.

If it is assumed[1] that thermal hardening is due to the movement of dislocations out of the crystal or into positions where they cannot be moved easily by the applied stress, the effects of temperature, pre-strain, and impurities are easily understood. At higher temperatures, the movement of dislocations takes place more rapidly; greater pre-strain produces a higher density of dislocations which, by their mutual interaction, impede each other's movement[5]; and the presence of impurities leads to internal stresses which act as barriers to the movement of the dislocations and slows down the process of their elimination. The new fact of the dependence of thermal hardening on the orientation of the crystal, however, does not seem to be explicable on such general assumptions.

I would like to thank Dr. E. Orowan for helpful discussions, and the British Iron and Steel Research Association, under the auspices of which the work was done, for permission to publish this paper.

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June 20.

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Surface Tension and Detergency

THE surface tension of an aqueous solution has long been recognized as one of the more important physical properties controlling its wetting and detergent powers, though early attempts to correlate these powers with equilibrium surface tension met with limited success. It is becoming generally appreciated that factors other than solute concentration influence surface tension, and that the condition of the surface must also be taken into account. Thus, the surface age involved in many detergent processes does not exceed a few seconds, and much of this time may be required for the establishment of diffusion equilibrium. For dilute solutions of long-chain compounds the operative dynamic tension may vary over a range of 40 dynes/cm., and acknowledgment of the time required for surface equilibrium is clearly essential. A further factor, the change in equilibrium surface tension which occurs during change in area of a soluble film, has not previously been considered, but may prove to have considerable significance.

In very dilute solutions, the decrease in tension is proportional to solute concentration, and the Gibbs adsorption equation simplifies to the linear $\gamma - \Gamma$ relation $\gamma = \gamma_0 - RT\Gamma$ typical of a gaseous film. Lateral cohesion, or repulsion between adsorbed molecules at higher concentrations, necessitates the introduction of correction factors; but these direct equations imply that the surface tension is dependent only on the surface excess Γ so long as the surface is stationary (that is, of constant area). However, recent experiments[1] have shown that the surface tension equivalent to a given surface excess per unit area of a long-chain adsorbate may be varied by as much as 10 dynes/cm. during expansion of the surface. If the adsorbed carbon chain is sufficiently long, the distribution of the forces between molecules at or near the surface (and thus the free surface energy) will depend upon the mean position of orientation of the adsorbed molecules. This orientation is likely to differ at stationary and expanding surfaces, and it is significant that the expansion effect is not apparent for short-chain solutes. Again, on contraction of a soluble film the migration of long-chain molecules away from the surface appears to take an appreciable time, so that a fresh contracting surface may contain an amount of adsorbed material in excess of the equilibrium amount.

Therefore, the surface tension of a solution, previously regarded as a function of bulk concentration and time only, must now be considered as subject to changes in area also, and the possible types of air–water interface may be subdivided as follows:

Dynamic stationary (1) → Equilibrium stationary (2) → Aged stationary (3)
Dynamic expanding (4)
Equilibrium expanding (5)
Dynamic contracting (6) → Equilibrium contracting (7).

The term 'dynamic' is restricted, as already suggested in *Nature*[2], to surfaces at which the initial surface excess is in the process of accumulating. The term 'equilibrium' implies that the initial diffusion required in the accumulation of the surface excess has been completed, though secondary diffusion processes resulting from changes in surface area may still be operative. Arrows indicate those surface types which pass from one to another with time; (4) can only pass into (5) by increasing the solute concentration. A similar range of surface types exists for liquid–liquid interfaces, though (3) is not well characterized.

The fresh surfaces operative in detergent processes are frequently expanding or contracting, and may fall into any one, or several, of the above types (except (3)). For a given solution, the surface tensions corresponding to these different surface types vary widely, and it appears essential that the type of surface involved should be determined before any successful correlation between surface tension and detergent power can be achieved.

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[2] Addison, *Nature*, 156, 600 (1945).

Optical Rotatory Power and Atomic Dimension

IN a recent paper by Brauns[1], an attempt is made to relate the differences in optical rotatory power of the respective alkyl halides and the differences in atomic dimensions of the halogens. The ratio of differences in specific rotation (*D* line) of the 2-halogenopentanes were found to be (Br, 41·6 — 42·6, Cl) : (I, 46·68 — 41·6, Br), that is, — 0·86 : + 5·08. Atomic dimension differences require (Br — Cl) : (I — Br) = 17·1 : 21·4, and on this basis the bromide should have a larger rotation than the chloride.

Whereas previous observations[2] mentioned by Brauns had led to the conclusion that 2-chloro-octane, $[\alpha]_D^{20^\circ}$ 35·8°, had a higher rotation than the bromide (best estimated maximum, $[\alpha]_D^{20^\circ}$ 33·8°), he now obtains 2-bromo-octane having $[\alpha]_D^{20^\circ}$ 40·6°, and providing a ratio of 17·1 : 30·3 for (Br — Cl) : (I — Br). In this observation he was preceded by Gerrard[3].

This question of maximum rotation of halides becomes even more interesting in the example of phenylmethylcarbinol. Whereas $[\alpha]_D$ 50·6° for 1-chloro-1-phenylethane[4] was for some time accepted as being near the maximum rotation, the rotatory power of the bromide being even less than this, Gerrard[5] obtained a specimen of the chloride having $[\alpha]_D^{16^\circ}$ 93·5°, by the interaction of the carbinol and phosphorus oxychloride in the presence of pyridine, and the bromide having $\alpha_D^{18^\circ}$ 131·4° ($l = 1$) by means of phosphorus tribromide and pyridine.

In a further examination of this subject, we are employing phosphorus oxybromide, the uses of which, in organic chemistry, do not appear to have been investigated. This reagent in the presence of pyridine gave rise to 1-bromo-1-phenylethane with $\alpha_D^{17°} + 125{\cdot}2°$ ($l = 1$), from ROH, $\alpha_D - 44{\cdot}0°$, and 1-bromo-1-phenylpropane with $\alpha_D^{16°} + 174{\cdot}2°$ ($l = 1$), from ROH, $\alpha_D^{10°} - 26{\cdot}4°$.

From the flattening of their rotation – reaction-temperature curves, Levene and Rothen[6] conclude that the maximum values of the molecular rotations of these bromides are respectively $[M]_D$ 90° and $[M]_D$ 140° (in benzene). Since Arcus[7] used these values to represent the experimental curves of Levene and Rothen in terms of percentage optical purity and the contributions of stated mechanisms to the rotation of the product obtained at the different temperatures, and since our values for $[M]$ (benzene) are nearly twice these, it follows that Arcus' curves and argument should be reconsidered.

W. Gerrard
W. Lessing

Northern Polytechnic,
Holloway Road,
London, N.7.
June 21.

[1] *Rec. trav. chim.*, **65**, 799 (1946).

[2] Cf. Houssa, Kenyon and Phillips, *J. Chem. Soc.*, 1700 (1929). Cowdrey, Hughes, Ingold, Masterman and Scott, *J. Chem. Soc.*, 1252 (1937).

[3] *J. Chem. Soc.*, 848 (1945).

[4] McKenzie and Clough, *J. Chem. Soc.*, **103**, 687 (1913).

[5] *J. Chem. Soc.*, 106, 848 (1945); 741 (1946).

[6] *J. Biol. Chem.*, **127**, 237 (1939).

[7] *J. Chem. Soc.*, 236 (1944).

Preparation of Colourless Carborundum

In a paper to Section I of the Eleventh International Congress of Pure and Applied Chemistry, J. T. Kendall and D. Yeo described the preparation of pure silicon carbide by passing the vapours of silicon-organic compounds over a heated carbon filament; the product they obtained was bright yellow in colour and it was not found possible to prepare colourless specimens by this method. On theoretical grounds it would be expected that pure silicon carbide should be colourless and, according to H. Moissan[1], carborundum free from traces of iron is without colour; he obtained almost colourless, prismatic needles of carbon silicide by allowing the vapours of carbon and silicon to react with one another. In view of current ideas on the part played by impurities in determining the electrical properties of semi-conductors, it is of interest to record another and simpler method by which colourless carborundum can be prepared.

The following observations were made during a study of the deposition of carbon from the gas phase on fused silica. The experiments were carried out in a long vitreosil tube 0·8 in. internal diameter, heated electrically. Inside this tube was another vitreosil tube, 6 in. long, 0·4 in. internal and 0·6 in. external diameter, provided with lugs so that an annulus was left between the two tubes. The temperature was measured by means of a Pt/PtRh thermocouple, surrounded by a vitreosil sheath, situated axially in the tube. Ethylene, saturated with water vapour, was passed through this apparatus heated to 1,200° C. at a constant rate of twenty-five litres (measured at room temperature) an hour. In one experiment, which had lasted several hours, in addition to the carbon deposit there was formed on the centre part of the outer surface of the inner silica tube a white, fluffy, mould-like growth. An X-ray powder photograph showed this to be cubic carborundum; although only microcrystalline, the back reflexions in the powder photograph were sharp and resolved. In appearance it was quite unlike the greenish-yellow cubic variety formed when carbon reacts with silica at higher temperatures; it had a soft texture and readily gave an extruded rod for X-ray examination when mixed with a little dilute gum arabic solution. First attempts to repeat this preparation were unsuccessful, possibly because the surface of the silica tube must be in a specially active condition. At a somewhat higher temperature (1,300° C.), however, it was found possible to repeat the formation of this white form of cubic carborundum.

R. Iley

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[1] "Comprehensive Treatise on Inorganic and Theoretical Chemistry", Mellor, J. W., **5**, 879.

A Volatile Compound of Copper

Körösy[1] has recently reported that copper formate decomposes when heated, evolving a small amount of a volatile copper compound. I encountered a similar phenomenon when gently igniting a deposit from a copper rectifying column, the deposit containing cupric acetate. According to Angel and Harcourt[2] the formation of a white sublimate of cuprous acetate on heating cupric acetate was first observed so long ago as 1773 by Lassone[3]. The formation of such volatile compounds may result in low values for the copper content of such materials as vinegar when dry-ashing methods are used in their analysis.

J. G. Maltby

Research and Development Department,
The Distillers Company, Ltd.,
Great Burgh,
Epsom, Surrey.
July 31.

[1] Körösy, F., *Nature*, **160**, 21 (1947).

[2] Angel, A., and Harcourt, A. V., *J. Chem. Soc.*, **81**, 1385 (1902).

[3] Lassone, "Histoire de l'Acad. Royale des Sciences", 26 (1773).

A Crystalline Principle from *Ammi majus* L.

Ammi majus L.[1] (Umbelliferæ) is an annual herbaceous plant which is widely spread in the Nile delta region and closely resembles *Ammi visnaga* L. The fruits of *Ammi majus* are taken internally by the public to cure leukoderma.

The powdered fruits of *Ammi majus*, collected in May, were extracted by hot petroleum ether (b.p. 60–70°) and the extract kept in the ice chest overnight, when a crystalline greenish mass separated, from which a colourless crystalline principle m.p. 148° was isolated, and for which the name 'ammoidin' is proposed (I. R. F. and H. A.). The crystalline substance was investigated chemically (A. S. and A. S.). It is easily soluble in chloroform and benzol, and contains neither active hydrogen nor acetyl group. The methoxyl test is positive and the substance does not react with diazomethane. It seems not impossible that the substance is related to ‘kellin’[2], which is used in the treatment of angina and bronchial asthma[3].

Further work from the pharmacognostical and chemical sides is in progress.

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Aug. 5.

[1] Fahmy, I. R., and El-Keiy, M., *Rep. Pharmaceut. Soc. Egypt*, **3**, 72 (1931).

[2] Spaeth, E., and Gruber, W., *Ber.*, **71**, 106 (1938).

[3] Anrep, G. V., Barsoum, G. S., Kenawy, M. R., and Misrahy G., *Lancet*, **1**, 557 (1947).

An Apparatus for Preparative Electrophoresis

A considerable number of suggestions have been made[1] of arrangements for the separation of ionized substances of different mobilities in an electric field, involving, for example, (1) diaphragm cells with three or more compartments[2], (2) a series of beakers connected by inverted U-tubes[3], (3) tubes filled with sintered glass[4], (4) slabs of silica gel[5], (5) modifications of the Tiselius apparatus which permit the withdrawal of liquid from any section of the advancing front[6].

(1) and (2) suffer from the disadvantage that convective and electro-endosmotic streaming occur in the compartments, so that the useful separative process is confined to the membranes or narrow tubes; (3) has an unduly high resistance; (4) has been successfully employed for comparatively small peptides. It is anticipated that the gel may hinder the free migration of larger molecules; and the problems of detection within the jelly and separation from it become formidable when only a few milligrams of material are available. The Tiselius apparatus is essentially one for the analysis of the moving fronts, and though samples can be withdrawn for analysis, it does not permit a complete separation of the components of a mixture.

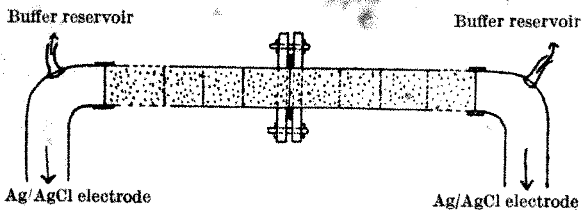

Fig. 1. Preparative electrophoresis apparatus

After a number of trials of other types, we have developed a simple apparatus which gives satisfactory results so far as it has been tested (Fig. 1). Migration is made to occur down a tube of thin polystyrene plastic material, about an inch in diameter and a metre long, which is fairly loosely filled with asbestos fibre of the type usually used in Gooch crucibles. This does not greatly increase the resistance of the column when filled with the buffer solution, and effectively prevents convective spreading. The asbestos is divided into sections by filter paper barriers at 1-inch intervals. These permit the wads of asbestos to be separated with ease when removed from the tubes. The tube is divided into two halves, fitted with plastic end-pieces, which enable them to be clamped together, making with a rubber washer a water-tight junction. The tube can be divided into as many sections as may be convenient, and sections can be removed or added during the electrolysis without disturbing the remainder. The tube is cooled by a water sprinkler placed above it.

The solution to be examined (about 5 c.c. in this apparatus) is mopped up with dry asbestos and introduced into the tube at the middle join. It is important that the solution and the buffer present in the rest of the column should be at the same *p*H and have approximately equal specific conductances; otherwise migration anomalies occur. The electrodes are of silver – silver chloride in concentrated sodium chloride similar to those used with the Tiselius apparatus. They are completely closed, so that no transport of the solvent occurs through the column.

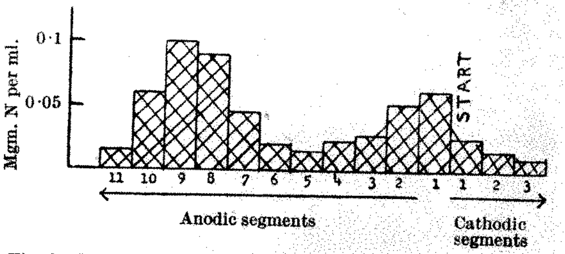

Fig. 2. Electrophoretic separation of glycine and glycylglycine at *p*H 9·3

In tests with coloured substances such as dinitrophenylglycine and coloured indicators it was found that the asbestos effectively prevents the convective dispersion of the coloured ions, which move down the tube without undue spreading. The asbestos wads are blown out of the tube by air pressure or pulled out by tongs after the experiment. It is a simple matter to squeeze the liquid contents of each segment into a test tube for analysis. Fig. 2 shows the analysis of the segments after electrolysis of a mixture of glycine and glycylglycine at *p*H 9·3 for 24 hours with a potential difference of 250 volts between the electrodes (approximately 2 volts per cm. in tube). It is clear that a good separation has been obtained, the fraction which has migrated towards the anode at this *p*H being glycylglycine. A more detailed account will be given elsewhere.

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J. M. L. Stephen

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July 29.

[1] For review, see Martin, A. J. P., and Synge, R. L. M., in "Advances in Protein Chemistry", Vol. II (1945).

[2] For example, Gordon, A. H., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **35**, 1369 (1941); **37**, 92 (1943).

[3] du Vigneaud, V., Irving, Dyer and Sealock, *J. Biol. Chem.*, **123**, 45, 485 (1938); *J. Amer. Chem. Soc.*, **63**, 503 (1941). See also Williams and Truesdail, *ibid.*, **53**, 4171 (1931); **55**, 2912 (1933).

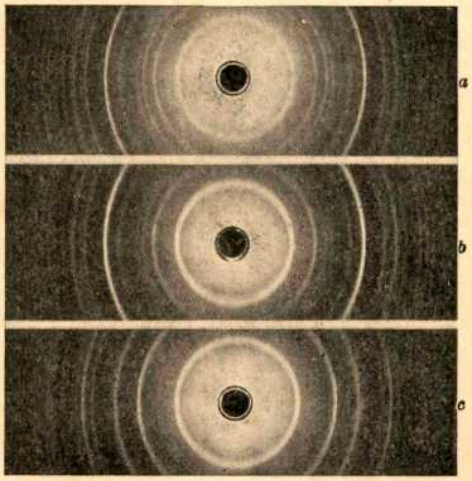
[4] Coolidge, T. B., *J. Biol. Chem.*, **127**, 551 (1939).

[5] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **40**, 33 (1946).

[6] Theorell, H., *Biochem. Z.*, **275**, 1 (1934). Svensson, H., *Arkiv. för Kemi, Min. o. Geol.*, **22A**, No. 10 (1946). Bunn, D., *Proc. Biochem. Soc.*, **41**, 24 (1947).

Identification of a Calculus from a Hippopotamus

During a recent visit to Nairobi, one of us (K. P. O.) secured, for purposes of determination, a fragment of a brown calculus of rather unusual origin which is preserved in the Kenya Game Department. Captain A. T. A. Ritchie, chief game warden, said that according to report this 'stone' was found in a hippopotamus killed on the Tana River some years ago. It was cut out of the animal by a native skinner, whose employer had passed it to Captain Ritchie. The location of the calculus in the animal was not recorded.



X-RAY POWDER PHOTOGRAPHS OF (a), ARTIFICIALLY PREPARED $CaC_2O_4.2H_2O$; b, POWDERED HIPPOPOTAMUS CALCULUS, $CaC_2O_4.2H_2O$; c, WHEWELLITE, BURGK, DRESDEN, SAXONY

The 'stone' is a flattened irregular ovoid with a smooth surface and, according to Mrs. M. D. Leakey, originally measured about 8 cm. × 6 cm. × 4 cm. It has been broken away on one side to a depth of nearly a centimetre, revealing a concentrically laminated structure and an apparently uniform composition. The fragment brought back to England is made up of concentric zones not more than 10 μ thick and readily cleaves into layers about 1 mm. thick. Chemical tests and X-ray powder photographs show that it is identical with tetragonal hydrated calcium oxalate, $CaC_2O_4.2H_2O$ [a 12·40, c 7·37 A.][1], and not with whewellite, the monoclinic monohydrate. Examination in polarized light reveals a minutely fibrous structure with fibre axis perpendicular to the plane of zoning, and X-ray diffraction photographs of stationary sections confirm that the fibre axis is c [001] but reveal that the orientation of the fibres across the plane of zoning is far from perfect. Moreover, there is no orientation of the [100] axes in the plane of zoning. The optical examination and X-ray photographs show that the layers are uniform in composition and crystal size, the length of each fibre not exceeding 10 μ and the cross-section being of the order of 1 μ.

Tetragonal calcium oxalate (weddellite) is very rare as a mineral but has been reported by two of us (F. A. B., M. H. H.) from one locality in the very deep water of the Weddell Sea, and its occurrence as minute 'envelope' crystals in plants and human urine is well known. Renal calculi from the human bladder are, however, usually of mixed composition, and those examined by us in 1936 were essentially fine-grained calcium carbonate-phosphate, similar to the mineral dahllite (carbonate-apatite), studded with large crystals (2–3 mm. across) of tetragonal calcium oxalate.

F. A. Bannister
M. H. Hey
K. P. Oakley

British Museum (Natural History),
London, S.W.7.
July 28.

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[1] Bannister, F. A., and Hey, M. H. Report on some crystalline components of the Weddell Sea deposits. *Discovery Rep.*, **13**, 60 (1936).

Structures Produced in Clays by Electric Potentials and their Relation to Natural Structures

If an electric potential is applied by means of two electrodes to a remoulded soil containing a proportion of particles of colloidal size, such as London clay, the soil develops a structure which is similar in appearance to that of the clay in its natural state. This phenomenon was observed by me in 1931 on a great variety of fine-grained soils. In recent investigations carried out on London clay and Wyoming bentonite, I found that the electro-osmotic transport of pore water towards the cathode results in the formation of cracks in the soil around and between the electrodes, the pattern of the cracks following the equipotential lines. These cracks, which are filled with free water, become more widely spaced with increasing distance from point electrodes. Originating from these basic cracks an irregular pattern of additional fissures is formed. When the soil becomes consolidated, as, for example, by continued electro-osmotic drainage or drying, the fissures

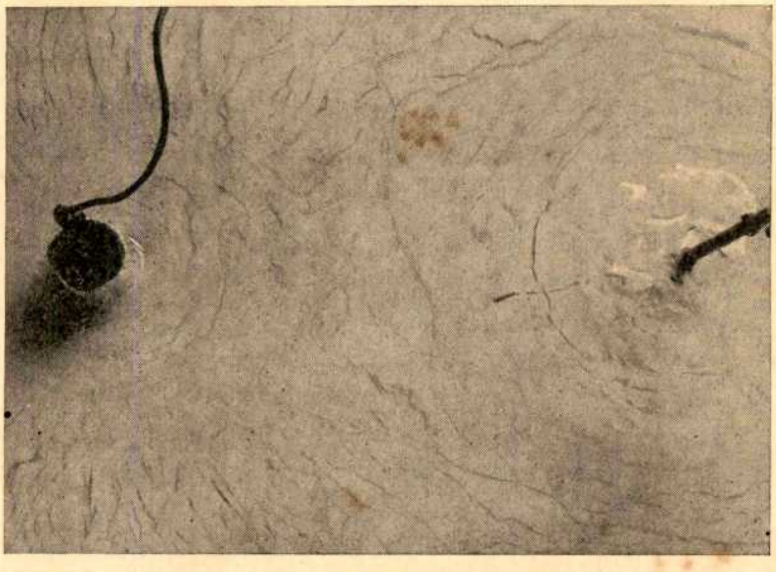

Fig. 1

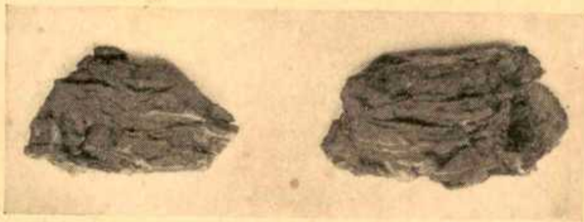

Fig. 2

and cracks close up but the structure remains even in the completely dry state and is readily revealed on breaking up the soil. Fig. 1 shows such a pattern in a gel of 2 per cent by dry weight of Wyoming bentonite, after a potential gradient of 0·2 volts per cm. was applied for forty hours. Surrounding the copper cathode (the thick electrode) concentric fissures in the process of formation can be seen.

Fig. 2 shows the laminated structure produced in a sample of what was originally uniformly remoulded London clay after treatment with a potential of 0·5 volt per cm. over a period of three months. The laminations follow the equipotential surfaces.

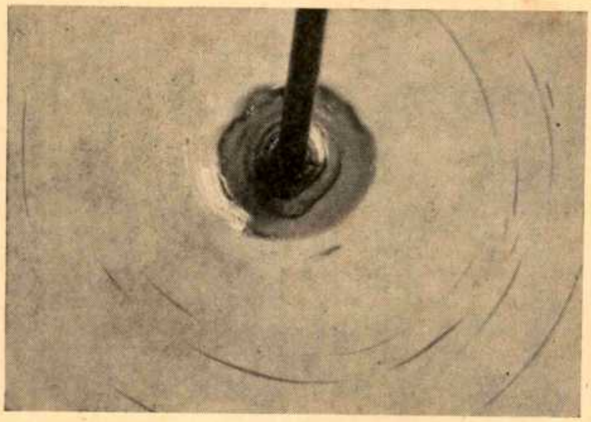

Fig. 3

Apart from the visible laminations in Fig. 2 the sample exhibits a random fissured structure with polished walls similar in appearance to the well-known fissures found in most old natural clays, for example, London clay, which were laid down by sedimentation. The greater the colloidal content of the soil, the more distinctly are the fissures developed, and this seems to conform to Nature where the more colloidal clays generally exhibit better developed fissures.

While the spaces between the individual laminations (equipotential lines) are similar at both electrodes, visible cracks do not always appear at the anode. Differences arise from the use of different metal anodes.

When an iron anode is used, an equipotential pattern of brown colour tones is produced from the anode, and with an aluminium anode in a bentonite suspension a practically colourless pattern develops, which may be seen in the form of slight ripples when the surface of the bentonite is viewed obliquely.

Under the microscope fine cracks forming an equipotential pattern are visible. Without exception, the anodic pattern (Fig. 3) resembles the well-known phenomenon of Liesegang rings[1].

It will be recalled that Liesegang in his experiments noticed that there was a marked concentration of water ahead of his rings. I have checked in a number of tests that the formation of Liesegang rings is associated with a considerable transport of pore water from the spot centre. The similarity between this and the anodic action in an external field suggests that the periodicity of precipitation may be conditioned by the development of cracks in the gel.

I feel that the concept of a water movement similar to the electro-osmosis arising from anodic action may have a useful application in connexion with many of the unsolved problems associated with the phenomena of rhythmic ring formation such as those which occur in flint and agate, and possibly in the pathological growth of concretions in man and animals.

The similarity between the laminations of Fig. 2 and those found in certain clay deposits, for example, varved clays, suggests an alternative explanation of the formation of varves to that given by De Geer[2] and his collaborators and pupils. The electric streaming potential originating from the natural consolidation of clay during deposition, or potentials arising from other external sources, could, it is suggested, produce laminations in clay in a similar way to those produced artificially in the laboratory.

This letter is published by permission of the Director of Building Research.

LEO CASAGRANDE

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Garston, Watford,
Herts.

July 29.

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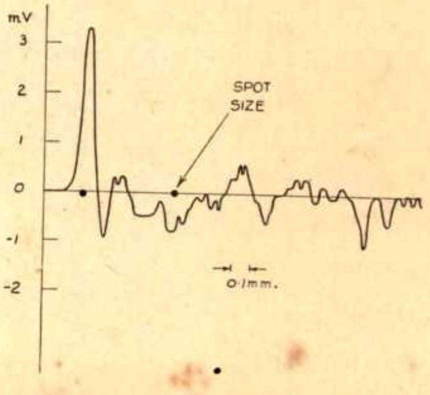
[1] Liesegang, R. E., *Phot. Archiv.*, **21**, 221 (1896).

[2] Geer, G. De, "Geochronologia Suecia: Principles" (1940).

Occurrence of Random Photovoltaic Barriers in Photoconductive Layers

IN two previous communications[1,2] the photoconductive properties of lead sulphide layers and a new photovoltaic effect were described. The latter effect is essentially a property of the semi-conductor and is not associated with the electrodes. A theory of the effect was outlined which attributed the photo-e.m.f. to the barrier between regions of excess and defect semi-conductors. It was further postulated that, in an apparently homogeneous photoconductive layer showing no external photo-e.m.f., there existed regions distributed at random which were predominantly either excess or defect semi-conductors. The photoconductive properties of the layer were also attributed to the barriers between these regions. Experimental evidence has now been obtained to justify this assumption.

Photoconductive layers have been scanned by a small spot of light, 30 microns in diameter, formed



by focusing, with a microscope objective, an image of a two-watt Western Union concentrated arc source. The photo-e.m.f. was measured using an electrometer triode. In every case a photo-e.m.f. was observed varying in magnitude and sign from point to point of the layer. The accompanying figure shows the typical variations for 2 mm. of a photoconductive layer of lead sulphide of about 1 micron thickness and 20 × 1 mm. area.

Since the theory is applicable to any substance which may exist as an excess and defect semiconductor, it was thought that the presence of photovoltaic barriers should be observed in photoconductive layers of substances other than lead sulphide. We are able to report preliminary results on layers of selenium which support the above conclusions. The photovoltaic effects observed in this case show, in general, the same magnitude and type of variation as those described for lead sulphide layers.

We have to thank Mr. J. S. Preston, of the National Physical Laboratory, for the preparation of the layers of selenium.

L. SOSNOWSKI
B. W. SOOLE
J. STARKIEWICZ

Admiralty Research Laboratory,
Teddington, Middlesex.

[1] Starkiewicz, J., Sosnowski, L., and Simpson, O., *Nature*, **158**, 28 (1946).
[2] Sosnowski, L., Starkiewicz, J., and Simpson, O., *Nature*, **159**, 818 (1947).

Radiant Temperatures of Walls in North–South and East–West Rooms

IN an investigation of indoor climate conditions initiated by the Indoor Climate Committee of the Meteorological Research Council in Palestine in the autumn of 1946 the mean radiant temperatures of walls of dwelling-rooms were (among other factors of the indoor climate) measured by means of the globe thermometer of Vernon. The observations were taken in two newly built houses of similar design, building materials, etc. The only difference between the two houses was in the orientation of the main fronts (longer walls): the main fronts of one house faced north and south, while those of the second one faced east and west. The actual observations were taken on the first floors of these (three-storied) houses. To be more precise:

(1) In the north–south house in a south room, whereby we mean a room (*a*) with a window on its south side; (*b*) communicating on its north side to another room with a window opening to north (the door between the two rooms was kept open during the whole period of observations); (*c*) on the east and west of the room there were other apartments, thus eliminating the direct climatic influence of the east and west fronts of the house.

(2) In the east–west house in an east room, whereby we mean a room the description of which will be obtained from that of the foregoing by substituting east for south and west for north.

The result of the observations was that the mean radiant temperatures of the walls in the east room have a double maximum during the day, one between 9 and 10 a.m. (local time) and the second one between 5 and 6 p.m. This would correspond to a maximum of irradiation by the sun of the east wall in the morning and the west wall in the afternoon. The south room has a single maximum occurring between 2 and 3 p.m.

The morning radiant temperature maximum of the walls in the east room is about 2½° C., the afternoon maximum about 1¼° C. higher than the instantaneous value of the mean radiant temperature in the south room. On the other hand, the single maximum in the south room is not above the instantaneous value in the east room. The mean radiant temperature of the south room is always below that of the east room.

If the windows be kept shut during the day, the room air temperature in the east room will have a slight local maximum at about 10 a.m. (the observations were taken at the height 1·20 m. above floor), followed by a decrease, and afterwards a fresh and more gradual rise to the afternoon maximum.

The significance of the above is clear for the better orientation of houses in a country with a long and warm summer—a thesis that has been advocated by the above Committee.

I am indebted to the Committee for permission to publish this note.

J. NEUMANN

Palestine Meteorological Service,
Jerusalem.
Aug. 1.

Technique of the Analysis of Variance

I AM afraid I disagree with Dr. Vajda's comments[1] on the analysis of variance technique appropriate to two-way tables with unequal frequencies in the different sub-classes. As I pointed out in the paper referred to[2], the expressions for the efficient estimates of the 'main' effects of the two variables are different according as interactions are assumed to exist or not. If interaction is assumed, the efficient estimate for the first variable in a 2 × 2 table, using Vajda's notation, is

$$a_1 = \tfrac{1}{2}\{(x_{11} - x_{21}) + (x_{12} - x_{22})\}.$$

If there is no interaction, it is

$$a_2 = \left\{\frac{n_{11}n_{21}}{n_{11} + n_{21}}(x_{11} - x_{21}) + \frac{n_{12}n_{22}}{n_{12} + n_{22}}(x_{12} - x_{22})\right\} \Big/ \left(\frac{n_{11}n_{21}}{n_{11} + n_{21}} + \frac{n_{12}n_{22}}{n_{12} + n_{22}}\right).$$

It is this latter expression that I derived by the method of fitting constants. (In the case of a 2 × 2 table it can, in fact, be written down directly by considering the variances of $x_{11} - x_{21}$ and $x_{12} - x_{22}$.) The expression for a_1 can, of course, also be derived by fitting constants, including a constant for interaction, though its form is obvious.

If all the sub-class frequencies are equal, the two estimates are identical, and this accounts for the formal simplicity of the analysis of tables with equal sub-class frequencies.

Snedecor[3] made an important further contribution to the subject when he pointed out that this formal simplicity is retained in the case of tables with proportionate sub-class frequencies ($n_{ij} = u_i v_j$), provided the main effect of each variable is re-defined as its average effect over the frequencies actually observed of the other variable instead of its average over equal frequencies of the other variable. In this case the estimate of the first variable is

$$a_3 = \frac{v_1}{v_1 + v_2}(x_{11} - x_{21}) + \frac{v_2}{v_1 + v_2}(x_{12} - x_{22}).$$

It will be noted that a_2 is identical with a_3 when the frequencies are proportionate.

The practical importance of this is that in the frequently occurring case when the observed frequencies, though very unequal, are nearly proportionate, an analysis can be made by the substitution of proportionate frequencies. This will not do any violence to the data, and will result in an immense reduction in computational labour. The estimates of the main effects so obtained are the same whether interactions exist or not; and, if interactions cannot be assumed negligible, are considerably more precise than those (a_1 above) obtained with the alternative definition of main effects.

There is consequently no logical inconsistency in the use of proportionate frequencies. If interactions exist, the magnitude of the main effects depends on the way in which they are defined, and the statistician must, of course, be clear what is implied. Inasmuch as the frequencies actually obtained are likely to be similar to those generally occurring in the type of material under consideration, the definition of the main effects implied by the use of proportionate frequencies is usually more appropriate in practice than that based on equal frequencies.

In conclusion, it may be noted that Dr. Vajda's first expression for the mean square gives the test of significance for a_1. His second expression gives the test of significance for a_3 (or a_2) when the frequencies are, in fact, proportionate; but in the more general form in which he has given it, it gives the test of significance for the estimate that would be obtained when the effect of the other variable and its interaction were both assumed negligible. It therefore has no relevance to the present argument.

F. YATES

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Harpenden,
Herts.
July 18.

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Nomogram for the Tetrachoric Correlation Coefficient

ONE of the most frequently used measures of association in psychology, and even in other biological sciences, is the tetrachoric correlation coefficient. Unfortunately, the computing of r_{tet} from the standard formula is extremely laborious, and the value of some aid to this end has been recognized from the earliest days. This has become more important than ever, when correlations are prepared in hundreds for one factor analysis. The earliest of the devices for computing measures of association is the *ABAC* of Burt, which consists of a family of curves on one graph[1]. Vernon has four such graphs[2]. The best known of such aids are the computing diagrams of Thurstone[3]. There are forty-six such diagrams, each consisting of a family of curves. They are quite simple to read when working to two decimal places; but this can lead to considerable inaccuracy, and three places involves interpolating between two diagrams, with four readings each, a very time-consuming procedure.

It was considered desirable to attempt the construction of a nomogram for the tetrachoric correlation coefficient, which would have the advantage of being easy to read, and of being contained in only one diagram.

The equation for the true coefficient is impracticable for this purpose, but it was found that the empirical formula developed by Karl Pearson was eminently satisfactory[4]. This is $r_{\text{tet}} = \sin\left(\frac{\pi}{2}\cdot\frac{\sqrt{ad}-\sqrt{bc}}{\sqrt{ad}+\sqrt{bc}}\right)$,

b	a	$a+b$
d	c	$c+d$
$b+d$	$a+c$	N

where a, b, c and d are the cell frequencies. This converts into $r = \cos\left(\pi\cdot\frac{\sqrt{bc}}{\sqrt{ad}+\sqrt{bc}}\right)$. If r is read in degrees (and appropriately scaled in the nomogram), the formula can be manipulated into $\sqrt{ad} = \sqrt{bc}\,.\left(\frac{180-r^\circ}{r^\circ}\right)$.

It is impossible to design a nomogram if the cell frequencies are kept in their original state, or converted into probabilities totalling unity. If, however, the cell frequencies are divided by one of them, for example, c, the equation becomes $\sqrt{AD} = \sqrt{B}\,.\left(\frac{180-r^\circ}{r^\circ}\right)$, where $A = a/c$, $B = b/c$, $D = d/c$ and $C = c/c = 1$. This eliminates the non-independent variable in the only way suitable for the present purpose.

This equation can be used for the construction of a nomogram in two ways. Taking logarithms:

$$\log A + \log D = \log B + 2\,.\log\left(\frac{180-r}{r}\right),$$

from which the two following determinants are obtained:

$$\begin{vmatrix} -1 & \log A & 1 \\ 0 & \tfrac{1}{2}R & 1 \\ 1 & \log D & 1 \end{vmatrix} = 0 \qquad \begin{vmatrix} -1 & \log B & 1 \\ 0 & \tfrac{1}{2}R & 1 \\ 1 & 2\log\left(\frac{180-r}{r}\right) & 1 \end{vmatrix} = 0$$

where R stands for a reference line

This nomogram consists of three parallel lines, the first being a logarithmic scale for A and D, the third a logarithmic scale of the same size for D, and of twice the size for $\left(\frac{180-r}{r}\right)$, which is then re-scaled for $\cos r^\circ$, and the second is a reference line halfway between. To read it, a line is drawn between A and D, and the point of intersection with the reference line joined to B and prolonged to r.

A more compact nomogram in the shape of a circle can be constructed by deriving from the equation as it stands the two determinants

$$\begin{vmatrix} \frac{A}{A+1} & \frac{\sqrt{A}}{A+1} & 1 \\ \frac{1}{1+R^2} & \frac{-R}{1+R^2} & 1 \\ \frac{1}{1+\sqrt{D}} & 0 & 1 \end{vmatrix} = 0 \qquad \begin{vmatrix} \frac{B}{B+1} & \frac{\sqrt{B}}{B+1} & 1 \\ \frac{1}{1+R^2} & \frac{-R}{1+R^2} & 1 \\ \frac{r}{180} & 0 & 1 \end{vmatrix} = 0$$

The upper half of the circumference is scaled for A and B, and the horizontal diameter for D and $\cos r^\circ$. The lower half of the circumference forms the reference line. The nomogram is read by joining A and D and prolonging the line to the circumference; the point of intersection is joined to B, and r read off. There are other ways of reading the nomograms, but this is the simplest for routine use. Other varieties of nomogram can be designed, if this method of eliminating one of the variables is used, for example, hexagonal and polar, but the two described are the simplest in use.

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Feeding Mechanisms of *Chironomus* Larvæ

THE large, hæmoglobin-bearing larvæ of the genus *Chironomus*, commonly known as bloodworms, are the most abundant and widespread members of the bottom mud communities in ponds and lakes, but owing to the obscurity of the medium in which they live little is known about their behaviour. The larvæ live in U-shaped tubes through which an intermittent irrigation current is maintained[1], and are stated to feed on the organic mud around them, eating part of the walls of their burrows or feeding off the surface of the mud[2]. Alsterberg[3], however, considered them to be largely plankton feeders, eating algæ brought in by the irrigation current and trapped by the tube walls or the spines of the anterior proleg. But details of their feeding mechanism or respiratory behaviour are unknown. Accordingly, I have watched the behaviour of larvæ of *Chironomus plumosus* L. under various conditions.

Glass U-tubes, resembling in proportions those which the larvæ construct in Nature, and perforating a small celluloid platform holding a thin layer of mud (Fig. 1), housed the larvæ. Platform and tubes were placed in water in small glass aquaria. In the course of the observations a feeding method was discovered which has not previously been described. The larvæ were seen to feed largely on suspended matter filtered out of a stream of water set up through the tube by their own activity. This feeding is carried out as follows. Maintaining its position in the tube by means of firmly anchored posterior prolegs, the larva performs a number of rotatory movements of the anterior region of the body, the head describing complete circles of alternating direction round the wall of the tube. While these movements are being made the anterior proleg draws out strands of salivary secretion by rapid approach to, and withdrawal from, the mouthparts, the strands being attached to the walls of the tube and stretched across its lumen to form a loose, saucer-shaped sheet. The larva then withdraws a few millimetres down the tube, dragging with it a salivary thread from the middle of the sheet, which is thus pulled out to form a shallow conical net (Fig. 2). Attached to the thread with its mouthparts, it begins violent antero-posterior undulations of the body with a frequency of about two per second. These have the effect of producing a current of water through the tube, and particles suspended in the water are caught by the conical net. The larva next straightens its body and rapidly eats the cone with the suspended matter on it; it then at once spins another web. The whole process is remarkably rapid, successive cones being formed and eaten at the rate of one every 1½–2 min. Approximately half the time is spent in undulating and the other half in eating and making the net. Although these time intervals vary for individual larvæ their repetition is very regular, and the whole performance forms a very stereotyped behaviour pattern which may persist for an hour or more with a regularity uninfluenced by the degree of loading of the net. More rarely, larvæ omit the net-spinning process and, instead, between the periods of irrigation, scrape the walls of their tubes which, being lined with salivary secretion, also trap particles. Very occasionally they feed from the mud surface; in doing this, they extend the body out of the tube entrance, retaining contact with it by means of the posterior prolegs, and spread a net of salivary secretion over the mud, which is then dragged down with its attached particles for consumption in the seclusion of the tube.

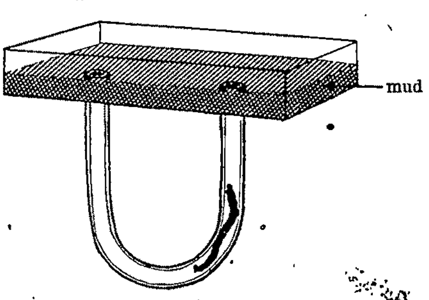

Fig. 1

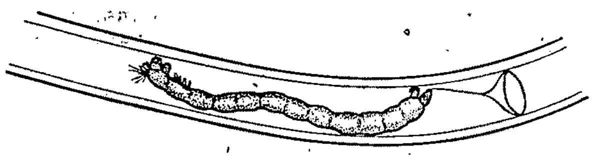

Fig. 2

The filtering method is, however, the commonest feeding mechanism in *C. plumosus* and resembles that of leaf-mining chironomids[2,4], except that in the latter the larva turns round after spinning the salivary cone, which is therefore posterior to the larva with the apex pointing away from the body. It also recalls the feeding mechanism of *Urechis caupo*, in which a long cone is secreted by the echiuroid worm and remains attached to the head during the irrigation of the U-shaped burrow[5]. In this case the cone is of mucus with pores of ultramicroscopic diameter and consequently high filtering efficiency[6].

I estimated the filtering powers of the nets of *Chironomus* by introducing into the inhalant current a suspension of carmine, and measuring the diameter of the particles before and after passing through the tube. The nets retain all particles bigger than $17\,\mu$ in diameter and most of those bigger than $12\,\mu$ in diameter, and would thus trap many planktonic organisms in addition to any particles of detritus, etc., temporarily suspended in the water as a result of agitation of the mud surface. The larvæ are unselective feeders in that they eat indiscriminately all particles attached to the net.

The observations have so far been confined to the larvæ of *Chironomus plumosus*, but it is likely that the other closely related species have the same habits. These larvæ provide one more example of a semi-sedentary animal solving the feeding problem by means of a filter mechanism.

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NUCLEAR MAGNETIC RELAXATION

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THE method of nuclear paramagnetic resonance absorption[1] has been used to study the interaction of nuclei in solids, liquids, and gases with their environment. The two important quantities are the relaxation time T_1, describing the energy transfer from the nuclear spin system to the whole of the sample, representing the heat reservoir, and the interaction among the nuclei alone, which can be described by a spin-spin relaxation time T_2. From the theory of Waller[2] one can predict the relaxation time T_1 caused by interaction of the nuclei with the lattice vibrations. The time obtained is at least 10^4 times larger than the experimental values[3,4,5].

We shall show that another process, occurring in many substances, provides a 'local field spectrum'[5] intense enough to account for the observed relaxation times. Every nucleus experiences not only the constant field H_0, and the applied radio-frequency signal H_1 perpendicular to H_0, but also the local field produced by neighbouring nuclear moments and sometimes by small moments caused by molecular rotation, or in paramagnetic substances by large electronic moments. In liquids and gases, at least, the carriers of these neighbouring moments are not stationary but execute Brownian motion, changing position relative to the nucleus under consideration in a random fashion. Consequently, the local field $H(t)$ will be a random function with a correlation time τ_c, in which the relative position of the neighbours changes significantly. The intensity in the Fourier spectrum of a random function[6] is nearly constant for frequencies $\nu \ll 1/\tau_c$, and falls off rapidly for $\nu \gg 1/\tau_c$. If we assume the correlation function to be of the form,

$$\overline{H(t)H(t+\tau)} = \overline{H^2(t)}\, e^{-t/\tau_c},$$

we obtain for the intensity,

$$H^2(\nu)\Delta\nu = 4\overline{H^2(t)}\,\frac{\tau_c}{1+4\pi^2\nu^2\tau_c^2}\,\Delta\nu.$$

Now components of this spectrum perpendicular to H_0 at the Larmor frequency ($\nu_0 = 2\mu H_0/h$) of the nuclei will induce transitions just as does the applied radio-frequency signal. The transition probability for this process is (for spin $I = \frac{1}{2}$)

$$W = \frac{\mu^2}{4\hbar^2}\, H^2(\nu_0).$$

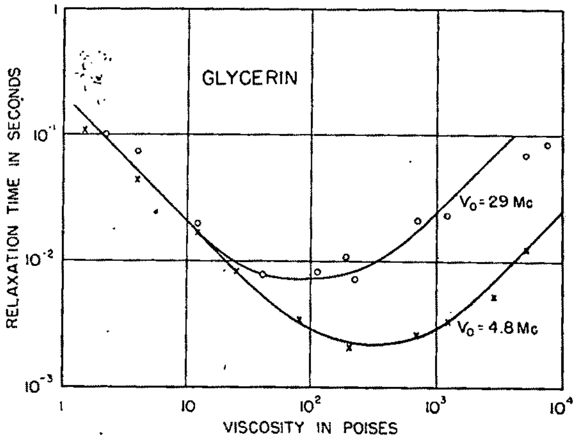
This process provides an interaction between nuclear spins and thermal motion with a relaxation time

$$T_1 = \frac{1}{2W} = \frac{\hbar^2}{\mu^2}\,\frac{1+4\pi^2\nu^2\tau_c^2}{\tau_c}\,\frac{1}{\overline{H^2(t)}}. \qquad (1)$$

$\overline{H^2(t)}$ could, in principle, be calculated for each substance, but will always be of the order $(\mu/r^3)^2$, where μ is the value of the neighbouring moment and r the internuclear distance. The correlation time τ_c can be estimated roughly, as in Debye's theory[7] of polar liquids, from the viscosity and the molecular dimensions. It is perhaps just as accurate in some cases to adopt the experimentally measured Debye time for reorientation of molecules under the influence of Brownian motion, although we must note that in the motion here discussed the neighbours of a molecule as well as the molecule itself are involved. A more refined theory would provide an appropriate distribution of relaxation times. In any event, we expect τ_c to be proportional to the viscosity. We now distinguish two cases: (*A*) $\tau_c \ll 1/\nu_0$, (*B*) $\tau_c \gg 1/\nu_0$. We see from (1) that in case (*A*) T_1 is inversely proportional to the viscosity. In case (*B*) T_1 is directly proportional to the viscosity. In most liquids we have case (*A*). The Debye relaxation in water, for example, occurs in 3×10^{-11} sec. at 20° C. Taking this as τ_c, we obtain with $\nu_0 = 29$ Mc./sec. a nuclear relaxation time of 5 sec., whereas the value of T_1 found in our experiments is 1·5 sec.

The relaxation time is measured by a saturation procedure. The power absorbed by the nuclei relative to the incident power is proportional to the surplus number of nuclei in the state of lower energy. This surplus will fall off rather abruptly if the incident power is increased sufficiently to raise the temperature of the system of nuclear spins.

The relaxation time in ethyl alcohol has been measured at 29 Mc./sec. and 4·8 Mc./sec., between + 60° C. and − 30° C. T_1 is found to be inversely proportional to the viscosity and independent of frequency (case *A*). The accompanying graph shows the relaxation time in glycerin for the same two frequencies and in the same temperature range. It displays all the features predicted by the theory, and shows the transition from case (*A*) to case (*B*). The minimum occurs for $\tau_c = 1/2\pi\nu_0$.



NUCLEAR MAGNETIC RELAXATION TIME T_1 FOR PROTONS IN GLYCERINE

Similar considerations seem to hold for some solids, in which the molecules still have, to some extent, a rotational degree of freedom. This is the case in ice, which also shows a dielectric dispersion. The relaxation time in ice has been measured from −2° C. (0·8 sec.) to −40° C. (20 sec.) at 29 Mc./sec., and is proportional to the Debye time τ_c, obtained from electric dispersion data. It is of the same order of magnitude as in water, but for a different reason, as we are on the other side of the minimum. Although Debye's theory is only concerned with polar molecules, it is clear that τ_c can be defined in a similar way for non-polar liquids. Measurements on a series of hydrocarbons from petroleum ether to heavy mineral oil show a decrease of the relaxation time from 2 sec. to 0·005 sec. with increasing viscosity. The local field $H(t)$ can be greatly enhanced by addition of a paramagnetic substance, resulting in a corresponding decrease in relaxation time. Data have been obtained for solutions containing Fe^{+++}, Cu^{++}, Er^{+++} in concentrations from 0·0002 to 0·5 mol. The relaxation time is inversely proportional to the concentration and, roughly, to the square of the magnetic moment of the ion. For F^{19} and Li^7 resonances in liquids results have been found similar to those for protons. Furthermore, the deuteron resonance has been observed at 4·8 mc. in a water sample containing 50 per cent deuterium. The relaxation time for D in this sample is 0·1 sec. Although the deuteron has a much smaller magnetic moment than the proton, this time is twenty times shorter than that for protons in the same sample, and must be ascribed almost entirely to the action of the quadrupole moment. One can repeat the above calculations for the electric quadrupole transitions by considering the 'local field spectrum' of the tensor grad·**E**. With the known value of the quadrupole moment, one obtains the experimental value of the relaxation time for a reasonable value of grad E in the polar liquid.

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Finally, we must consider the spin-spin relaxation time and the closely related problem of the line width. In the limiting case of a solid in which the motion of molecules is very small, the line width can be calculated on the basis that the nuclei are at rest[8], and spin-spin relaxation is produced by the fact that neighbouring nuclei precessing with the Larmor frequency can exchange their energy. On the other hand, in a liquid like water, this exchange will be much smaller, since the rapid Brownian motion smears out the spectrum and averages out the local field. We conclude that in liquids ($\tau_c \ll 1/\nu_0$), T_1 and T_2 are proportional and of the same order of magnitude. But while T_1 passes through a minimum at $\tau_c = 1/2\pi\nu_0$, T_2 continues to decrease. The line width is a monotonic function of viscosity, at first linear, and asymptotically reaching a limiting value in the solid. Confirming this view, we find experimentally that the resonance line in water, glycerin, and other liquids at room temperature is extremely narrow. At 4·8 Mc./sec., an upper limit of 0·015 gauss has been established. The theoretical value according to the above considerations would be 0·007 gauss for glycerin and about 10^{-4} gauss for water. The broadening of the line in glycerin, mineral oil and ice, which can be observed at sufficiently low temperatures, is such that the line width is initially proportional to τ_c. In glycerin at $-30°$ C. the width is 1·5 gauss, in ice at $-5°$ C., 5 gauss, at $-30°$ C., 15 gauss. The line width in solutions of ferric nitrate is proportional to the concentration of the paramagnetic ion, and is 0·6 gauss in a 0·5 mol. solution with a relaxation time $T_1 = 3 \times 10^{-4}$ sec.

A detailed account of this investigation will be sent to the *Physical Review* and will appear in a thesis to be submitted by one of us (N. B.) at the University of Leyden.

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STATE LABORATORY FOR EXPERIMENTAL BIOLOGY AND MEDICINE, NOVI SAD, YUGOSLAVIA

By Dr. PETAR N. MARTINOVITCH

Director

WHILE fighting was still going on in the Pannonian plains north-west of Beograd in 1944, a small group of young medical men and medical students (most of them in uniform) was busy collecting material left behind by the Germans, destined to become the nucleus of the present Laboratory for Experimental Biology and Medicine at Novi Sad, Yugoslavia. In due course they called on me to tell me that they wanted a laboratory for biomedical research. A site for the laboratory was yet to be found. Eventually, a deserted villa on the outskirts of the town was selected; but it was in an appalling condition, and many months of work were necessary to make it suitable for our purpose.

The United Nations Relief and Rehabilitation Administration sent a large amount of laboratory material to Yugoslavia; but it had to be shared by many laboratories and much of it was assigned to field work. Some valuable items, however, were allotted to our institute. Finally, due credit should be given to the progressive citizens of Novi Sad, who spared no effort to help the new laboratory. To-day the Laboratory is a State institution, and the authorities are giving ample credits for its support.

The available space in the Laboratory consists of four large rooms and six smaller ones. One room has been fitted for tissue culture work, and in the cellar there are a workshop, a washing room and a room where experimental animals can be kept. The building stands in a small park, and at the back is a garden with an enclosed space for poultry. The Laboratory is equipped with essential apparatus, instruments and a fair amount of glassware and necessary chemicals; all the equipment of my tissue-culture laboratory at Beograd was transferred to Novi Sad. The Laboratory owns eight hectares of arable land, where the animals are kept and the animal food grown.

Although the official status of the Laboratory was established in May 1946, experimental work did not begin until several months later.

The new Laboratory is being organised on a modest scale along the lines of the Strangeways Research Laboratory at Cambridge. No separate departments are planned and no programme of 'division of labour' on the research level will be attempted. Each laboratory unit will be developed around the man and the field in which he is most interested. Collaboration will be encouraged whenever necessary. No attempt will be made to encourage the Laboratory to grow beyond a certain definite size.

The Laboratory has four objectives, as follows: to bring under the same roof workers engaged in various fields of experimental biology and medical research; to establish the closest possible contacts with laboratories in other lands engaged in the same kind of work; to give an opportunity to promising young people interested in biomedical research to obtain elementary instruction in research methods, in order that they may be sent abroad sufficiently trained for advanced work; to 'popularize' biological science by publishing books and articles on recent advances made in this field of research.

At present there are only two of us working in the Laboratory, a young doctor of medicine and myself. We are expecting a third, a bacteriologist, to come from the United States, where he has been sent by the Rockefeller Foundation for special training. There are also several young men, now university students, whom the Laboratory hopes eventually to appoint to its staff. The problems at present being studied deal with the morphogenesis of the mammalian gonad, primarily of the germ cells, and with the gonadotrophic function of the pituitary gland.

The long years of war and occupation were a heavy blow to science in Yugoslavia. All research work was brought to a standstill. Completely shut off from the rest of the world, lacking even the most essential equipment for carrying on research, the small number of Yugoslav biologists, even if left alone by the enemy authorities (some were killed or imprisoned), were obliged to struggle for the bare necessities of life for themselves and their families. Since the War has ended, great efforts have been made to pick up the broken threads. But even now there are many obstacles. There is a shortage of almost every article essential to a research laboratory, great difficulties are encountered in replenishing depleted stocks, and reserve parts of precision apparatus are hard to get. Trained laboratory technicians are few, and so are electricians and mechanics acquainted with laboratory apparatus. We are also in dire need of technical books, journals and reprints of scientific papers. We would welcome reprints covering every field of biology and medicine, and the Laboratory at Novi Sad will be glad to forward them where they are most needed.

THE CHEMICAL SOCIETY'S CENTENARY EXHIBITION

THE exhibition at the Science Museum, arranged as part of the centenary celebrations of the Chemical Society, was a memorable one. For the first time, through the co-operation of the director of the Museum, Dr. H. Shaw, a comprehensive display of exhibits illustrating the progress of chemistry in Britain over the past hundred years was housed under one roof.

The exhibition, organised on behalf of the Chemical Society and the XIth International Congress of Pure and Applied Chemistry, by a committee under the chairmanship of Sir Robert Robertson, was divided into two parts, illustrating the history and the everyday uses of chemistry. The historical side was arranged under ten headings, each dealing with a section of the subject. Each section has been in the care of a panel of experts responsible for the selection of the exhibits, and for the corresponding chapter of the handbook to the exhibition. This handbook, "Chemical Progress" (London: H.M. Stationery Office. 1*s*. 6*d*. net), is a brief yet comprehensive survey of the British contribution to the science, which future students of chemistry may consult as a historical guide. The chairmen of the panels were Dr. A. E. Alexander, Dr. G. M. Bennett, Prof. J. D. Bernal, Prof. H. V. A. Briscoe, Dr. E. M. Crowther, Prof. C. W. Davies, Prof. D. H. Hey, Prof. C. N. Hinshelwood, Prof. E. K. Rideal, Prof. N. V. Sidgwick and Prof. M. W. Travers. The reports have been edited by Dr. F. Sherwood Taylor, curator of the Museum of the History of Science, Oxford.

A modern section dealing in a popular manner with "Chemistry in Everyday Life" was prepared by the Department of Scientific and Industrial Research, with the co-operation of the Agricultural Research Council, several research associations, and a number of industrial firms. The Central Office of Information prepared the layout of this part of the exhibition, which surveyed such fields as agriculture and food, health, homes and building, fuels, oil, transport and engineering. A popular account of this side was written by Dr. J. P. Lawrie, and this forms the second section of the handbook.

The exhibition was opened on July 14 by the president of the Chemical Society, Prof. C. N. Hinshelwood. The Minister of Education, Mr. George Tomlinson, was in the chair and welcomed the visitors. Prof. Hinshelwood in his opening speech said that the real adventures of science took place in the minds of men, and that much of the exhibition's interest would rely on the association of the objects to be seen with the men who used them.

It is impossible to do justice in the space of a short article to the many exhibits. In each branch of the subject the development was traced from the early pioneers. It was Faraday whose genius laid the foundations of so much of modern chemistry. His work on the alloys of steel was illustrated, as was that on the liquefaction of gases, the forerunner of all later researches in this field. His discovery of benzene was the start of modern organic chemistry, which was illustrated in all its aspects. His work on electrolysis has produced the modern science of electrochemistry, and the use of platinum as a catalyst. The visitor could also see, side by side with their more modern counterparts and developments, his samples of optical glass and colloidal gold.

Graham, too, the first president of the Chemical Society, was a pioneer whose experiments with simple apparatus led to the enunciation of the laws of diffusion in gases and liquids, and to the foundation of modern colloid science. The study of chemical reactions has increased our knowledge of molecular properties and brought about such material advances as photography and plastics. The early theories of valency and atomic structure put forward by Newlands and Crookes were demonstrated. These pointed the way for Mendeléeff, and also for Moseley, whose apparatus and ferrocyanide crystal were exhibited. In the range of inorganic chemistry the fundamental work of Dalton was illustrated by his diagrams of molecular structure. Near this were shown such diverse subjects as glass, precious metals, fluorine chemistry and fluorescent lighting, all items in which British chemists have played a decisive part.

The study of crystallography was represented by a large number of structural models and apparatus illustrating the development of theory and technique in this subject.

The important subject of agricultural chemistry, in which the early work of Lawes and Gilbert at Rothamsted pointed the way to modern scientific methods of increasing the fertility of the soil, was also given prominence.

It is, however, the organic chemist whose work offers the biggest variety of subjects. Each was illustrated by charts and specimens to show the structure, historical synthesis and applications of the substance. Individual exhibits showed early work in carbohydrates at St. Andrews and at Birmingham.

The development of synthetic dyestuffs and fibres was well represented, and space was given, to name a few examples, to synthetic drugs and chemotherapeutic substances including penicillin, and to British work on the vitamins.

The historical part of the exhibition was concluded by a small exhibit of British developments in analytical chemistry.

Space forbids a description of the attractive section on "Chemistry in Everyday Life", which explained in simple terms, by means of a series of illuminated screens and diagrams, the operations and processes by which the raw materials of the laboratory are turned into finished products.

It must be regretted that a historical exhibition on this scale cannot take a permanent place in the national collections, and it is to be hoped that when the Science Museum eventually obtains its long-needed extensions, an enlarged collection, on the lines of the exhibition which has just closed, may be reassembled.

CLIMATIC FLUCTUATIONS AND VEGETATION GROWTH IN NORTHERN FINLAND DURING 1890–1939

FIG. 1 shows the annual variations in the growth in diameter of pine (*Pinus silvestris* L.) near the timber line in the extreme north of Finland, at about lat. 69° 30′–70° N. The diagram is based on two series of figures[1]: (*a*) represents the weighted average of 148 increment cores collected in July 1939 and 1940; (*b*) represents the average of 58 increment cores collected in July 1945.

The diagram shows the great variation from year to year in the production of organic matter, in this case cellulose. We observe, moreover, an obvious 'low' period of growth during 1901–16, and the gradually increasing growth during the 1920's.

The timber-line forest is very susceptible to the smallest changes in climate (cf. the general statements by Griggs[2] and by Hustich[3]). Thus Fig. 1 may perhaps illustrate to some extent the general influence on growth in the northern part of the Eurasian coniferous zone of the most recent climatic changes. The names on the diagram are those of scientific workers who have expressed an opinion about the regression or progression of the timber-line. The signs − or + indicate that the author mentioned believed it to be receding or advancing respectively. Their opinions are reasonably well explained when considered in connexion with this cyclical growth curve. We can easily understand, for example, why Renvall[4], who worked in the 'low' period, demanded rigorous protection of the timber-line forest because of the "regression of the timber line"; and just as readily we understand why Eide[5], who worked in the 'good' period, was of quite another opinion. I think that the work of Russian scientific investigators on this subject during the same period would give a similar result. The 'low' period is also evident from the occurrence of seed years; there was no important seed year during the 'low' period, shown in Fig. 1, in the northernmost pine forests of Finland.

The same cyclical variation in the production of organic matter also appears in the crop variations of rye, barley, oats and potatoes in northern Finland. The positive trend or 'progression' in the period 1890–1939 is still more pronounced. The positive influence of the climatic improvement of the 1920's was, so far as cereals are concerned, over-accentuated by the improvement in cultivation methods in Finland in recent decades, and by the introduction of better varieties of the various cereals.

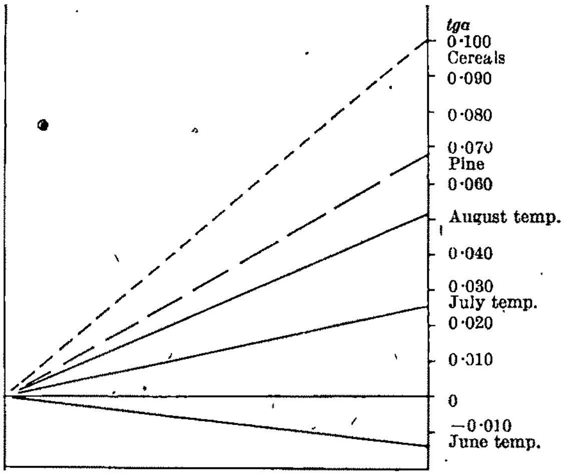

Fig. 2. THE *tgα*-COEFFICIENTS OF TEMPERATURE, CROP AND GROWTH (PINE) SERIES 1890–1939 ON AN EXAGGERATED SCALE. THE TERM 'CEREALS' IS THE AVERAGE OF THE CROP SERIES IN THE TABLE

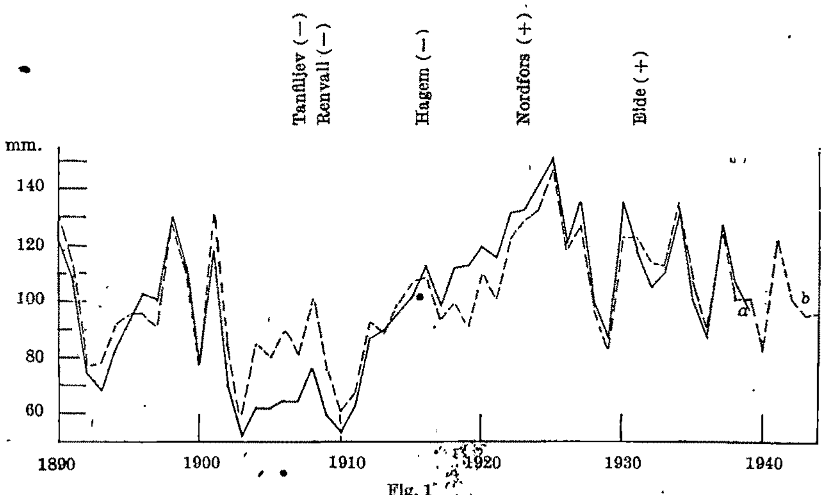

Fig. 1

In the accompanying table some information is given on the trend (the *tgα* coefficient of the series during 1890–1939) of some temperature indicators, and also of some crop-yield series and growth-series of pine (curve *a* in Fig. 1). The influence of precipitation on growth in the far north is, as is known, of minor significance.

We find that the June temperature shows a slight negative trend, but the July temperature, and especially the August temperature, increased appreciably during the period 1890–1939 (see Fig. 2). Moreover, the positive trend in the growth in diameter of pine is slightly higher than that of any climatic indicator, thus showing that even a fairly small increase in temperature may result in much accentuated growth[1]. The improvement in the cereal crop has been commented on above. Thus the table and Fig. 2 together give an idea of the general climatic influence on growth phenomena and on the production of organic matter during the period 1890–1939. (There are great annual variations not only in the quantity but also in the quality of the organic matter produced; for example, the annual variation in the amount of potatoes is not correlated with the variation in the percentage of starch of the crop.)

REGRESSION (*tgα*), STANDARD DEVIATION (σ) AND VARIATION COEFFICIENT (% σ/M) IN TEMPERATURE, CROP AND PINE GROWTH-SERIES IN NORTHERN FINLAND

Series (1890–1939)	*M*	*tgα*	σ	% σ/M
June temperature at 65° N.	12·8° C.	−0·014	1·7	13·7
July temperature ,,	16·5° C.	0·025	1·9	11·5
August temperature ,,	13·9° C.	0·051	1·7	8·9
Rye, relative crop values	7·2	0·106	2·2	30·3
Barley ,, ,, ,,	5·3	0·115	1·6	31·4
Oats ,, ,, ,,	5·1	0·076	1·6	30·2
Potatoes ,, ,, ,,	6·0	0·121	2·3	38·0
Pine growth (in 1/100 mm.)	99·8	0·068	2·6	25·7

In the table the variation coefficients (% σ/M) for the series used are also given. Note the high ratio of the annual variation, especially in the crop series, showing clearly the uncertainty of agriculture in northern Finland (north of lat. 65° N.).

The variation coefficient, or as I would prefer to call it, the 'climatic hazard coefficient', decreases when moving south, being only about 11 per cent for the crops in southern Finland.

In forestry the same phenomenon, namely, increased variability in growth towards the north, can be noticed. The growth measurements made during the second national forest survey of Finland during 1936–38 show that the 'climatic hazard coefficient' for pine is about 23 per cent in northern Finland and about 18 per cent in southern Finland, the corresponding figures for spruce being somewhat lower, namely, 20 per cent and 15 per cent, respectively. This increasing 'variation coefficient' or 'climatic hazard coefficient' from south to north which I have demonstrated corresponds fairly well with the idea that the 'improvement' in recent decades has been most evident in northern countries. It would be of interest to receive information from other parts of the coniferous zone concerning this subject.

I. HUSTICH

Botanical Institute,
Helsinki.

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[1] Hustich, I., *Soc. Scientiarium Fennica, Comm. Biol.*, 9, 11 (Helsinki, 1945).

[2] Griggs, R., *Science*, N.S., 85 (New York, 1937).

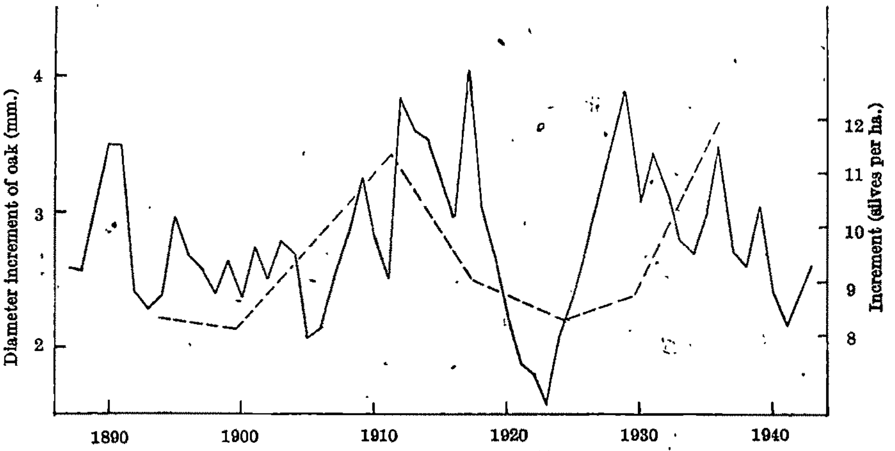
[3] Hustich, I., *Geograf. Ann.* (Stockholm, 1943).

[4] Renvall, A., *Acta Forestalia Fennica*, 1 (Helsinki, 1912).

[5] Eide, E., *Medd. Norske Skogsførs. vesen*, 3 (Oslo, 1932).

It seems probable that the fluctuations in plant growth in northern Scandinavia to which Dr. Hustich directs attention are examples of a general phenomenon which will prove to be traceable over the whole of the North Temperate region. Two further examples are shown in the accompanying figure. The first curve represents the mean diameter increment of eight old trees of oak (*Quercus sessiliflora* Sals.) growing in unenclosed woodland near Brook in the New Forest, Hampshire, England. Exactly the same trend is shown by rather younger oak (about two hundred years old) in adjacent enclosures, and by pedunculate oak (*Q. robur* L.) in other parts of the New Forest. The second curve represents the volume increment of mixed silver-fir–spruce forest in the Swiss Jura[1], in silves per hectare, between successive enumerations made at intervals of approximately five years. (A 'silve' is a volume of one cubic metre estimated from the diameter of the trunk and the known average diameter–volume relationship.)

Both these curves show unmistakably the tendency to rise from about 1890 until about 1930, but whereas, according to Hustich, the Finnish curves are unaffected by rainfall, the upward trend of the Swiss and English curves is interrupted by severe depressions associated with the dry periods culminating in 1921 and 1935. The fall in growth from 1930 onwards is shown both in Finland and in England, and it has continued throughout the wetter period which followed 1935, so that it may be associated with a fall in temperature—a possibility which is suggested by the temperature curves for Switzerland published by Favre; these curves show quite clearly the general rise in temperature from about 1890 up to 1930.



FULL LINE, MEAN DIAMETER INCREMENT OF OAK, NEW FOREST. BROKEN LINE, VOLUME INCREMENT OF SILVER-FIR-SPRUCE FOREST IN SWISS JURA

The rise in temperature over this period has apparently also been demonstrated in America[2], and it accords with much that is known concerning the behaviour of glaciers and ice-caps.

It seems clear that the investigation of the trends of growth shown by trees over long periods, as distinct from the attempts to interpret the peculiarities of individual rings, is a very promising field of work.

E. W. JONES

Imperial Forestry Institute,
Oxford.

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[1] For the Forest of Couvet; from Favre, E., *Schweiz. Z. Forstw.*, 95, 161 (1944).

[2] Kincer, J. B., *Biol. Abst.*, 27, No. 16763 (1946).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Saturday, October 4

Institution of Mechanical Engineers, Graduates' Section (at Storey's Gate, St. James's Park, London, S.W.1), at 3 p.m.—Discussion on "A Survey of Combustion Research as applied to the Internal Combustion Engine" (to be opened by Mr. N. P. W. Moore).

Monday, October 6

Society of Engineers (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. D. Mitchell: "Prefabricated Pre-Cast Concrete Structures, including Floating Craft".

Society of Chemical Industry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. J. W. Walker: "Synthetic Drugs in the Fight against Tropical Diseases".

Tuesday, October 7

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 2.30 p.m.—Brigadier A. E. Richmond: "Positive Health—its Attainment in the Soldier, and the Army's Contribution to it in the Civilian".*

Institution of Post Office Electrical Engineers, London Centre (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. J. Neale and Mr. W. E. Adams: "Some Recent Developments in the Design of Short Wave Receiving Stations".

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. J. Z. Young, F.R.S.: "The Structure of Peripheral Nerve and of Nerve Endings" (further lecture on October 14).*

Institute of Physics, Electronics Group (in the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. D. R. Hartree, F.R.S.: "Electronic Calculating Machines".

Institution of Mechanical Engineers, Automobile Division (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—First Annual General Meeting of the Division; Mr. S. Markland and Mr. N. Tattersall: "High Speed C.I. Engines".

Wednesday, October 8

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. M. H. Pirenne: "The Physiological Mechanisms of Vision" (further lectures on October 15, 22, 29, November 5 and 12).*

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. B. B. Morton: "Metallurgical Methods for Combating Corrosion and Abrasion in the Petroleum Industry".

Society of Chemical Industry, Microbiological and Nutrition Panels of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Discussion on "Microbiological Proteins; their Synthesis, Production and Feeding Value".

Thursday, October 9

Imperial Institute, Mineral Resources Department (in the Cinema Hall, Imperial Institute, South Kensington, London, S.W.7), at 3 p.m.—Mr. S. H. Shaw: "The Geology and Mineral Resources of Palestine" (Recent Progress in Geological Investigations and Mineral Developments in the Colonies, 8).*

Chemical Society (joint meeting with the University College of North Wales Chemical Society, in the Chemistry Lecture Room, University College of North Wales, Bangor), at 4 p.m.—Sir Ian Heilbron, F.R.S.: "D.D.T. and Gammexane in the Control of Insect-borne Diseases".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. Good: Inaugural Address as President.

Royal Aeronautical Society (in the Lecture Hall of the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. W. M. Widgery: "Pressurisation of Aircraft".

Friday, October 10

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Chemical Society (joint meeting with the Southampton University College Chemical Society, in the Physics Department, University College, Southampton), at 5 p.m.—Prof. C. C. Price: "The Influence of Substituents on the Polarity of the Benzene Ring".

Saturday, October 11—Saturday, November 1

Royal Photographic Society (at 16 Prince's Gate, London, S.W.7).—Ninety-second Annual Exhibition. Part 2: Scientific, Nature, Record and Technical.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Mining, and a Lecturer in Electrical Engineering at the Cannock Chase Mining College—The Director of Education, Dept. F.E., County Education Offices, Stafford (October 11).

Junior Laboratory Technician (Grade C)—Dr. M. Reiss, Bristol Mental Hospital, Fishponds, Bristol (October 11).

Teacher in the Mathematics and Physics Department—The Principal, Municipal Technical College, Hopwood Lane, Halifax (October 11).

Assistant in Agriculture at the Essex Institute of Agriculture—The Chief Education Officer, County Offices, Chelmsford (October 13).

County Agricultural Advisers (7), Experimental Officers (2), Horticultural Advisers (2), a Horticultural Instructor, Instructresses (2) in Dairying and Poultry-Keeping, and an Apiarist, for posts in the County Extension Services of the College—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (October 15).

Scientists (Grade III) for the National Coal Board: a Physical Chemist and Physicist in Greater London for laboratory research into dust problems in mines, Ref. No. F.794/47A, a Physicist for applied research in North Staffs coalfields on problems of firedamp and ventilation in mines, Ref. No. A. 339/47A, a Physicist for laboratory research on underground illumination, Ref. No. A.340/47A, and a Mechanical Engineer for laboratory research into development of dust control equipment, Ref. No. C.567/47A—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (October 18).

Senior Assistant in Mechanical Engineering, a Responsible Lecturer in Production Engineering, a Lecturer in Electrical Engineering, a Lecturer in Science Subjects (with either Chemistry or Biology or Metallurgy as a main subject), a Lecturer in Mathematics, and a Lecturer in Building Subjects—The Principal, Luton Technical College, Park Square, Luton (October 20).

Lecturers in Mechanical or Electrical Engineering in the Cape Technical College, Cape Town—J. A. Ewing and Co. (Ldn.), Ltd., Finsbury Court, Finsbury Pavement, London, E.C.2 (October 20).

Research Assistantship in the Nuffield Department of Industrial Health—The Registrar, King's College, Newcastle-upon-Tyne (October 31).

Soil Conservation Officer by the Government of Ceylon for the Department of Agriculture—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18513 (October 31).

Lecturer in the Mathematics Department—The Principal, Heriot-Watt College, Edinburgh (October 31).

Principal of the Paddington Technical Institute, Saltram Crescent, W.9—The Education Officer (T.1), County Hall, London, S.E.1 (November 1).

Assistant Lecturer in Mycology—The Registrar, The University, Manchester 13 (November 7).

Lecturer in Psychology at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (November 10).

Physicist or Physical Chemist (preferably with experience in electronics)—The Director, British Launderers' Research Association Laboratories, Hill View Gardens, London, N.W.4 (November 13).

Senior Lecturer in Psychology at the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (November 14).

Chair of Oriental Studies—The Registrar, University of Sydney, Sydney, N.S.W., Australia (November 30).

Assistant in Department of Chemical Pathology—The Chemical Pathologist, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1.

Engineer in the Ionosphere Section of the Overseas and Engineering Information Department of the B.B.C., based in London—The Engineering Establishment Officer, Broadcasting House, London, W.1.

Junior Organic Chemists—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

Laboratory Assistant to take charge of physics laboratory—The Bursar, Haileybury and Imperial Service College, Hertford.

Laboratory Assistant (Grade I) in the Department of Physiology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

Senior Lecturer in Agriculture—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

Biochemist (preferably with some experience of research) for work on the separation and properties of macro-molecules—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Head of the Electrical Engineering Department—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

A Plan for Science: a Memorandum produced by the Science Advisory Committee of the Communist Party. Pp. 32. (London: Communist Party, 1947.) 6*d*. [273

Medical Research Council. Special Report Series, No. 259: The Marine Type of Tubercle Bacillus (the Vole Acid-fast Bacillus). By A. Q. Wells, with Notes on the Morphology of Infection by the Vole Acid-fast Bacillus, by A. H. T. Robb-Smith. Pp. iv + 48 + 13 plates. (London: H.M. Stationery Office, 1946.) 2*s*. net. [273

Department of Scientific and Industrial Research: Building Research. Technical Paper No. 29: Weathering Tests on Asbestos-Cement Roofing Materials. By Dr. F. E. Jones. Pp. 38. (London: H.M. Stationery Office, 1947.) 1*s*. net. [273

Proceedings of the Royal Irish Academy. Vol. 51, Section A. No. 5: The Foundation of the Theory of Probability, 1. By Erwin Schrödinger. Pp. 51–66. 1*s*. 6*d*. No. 6: Stereographic Projection and the Linear Fractional Group of Transformations of Quaternions. By P. G. Gormley. Pp. 67–86. 2*s*. 6*d*. No. 7: Radiation Damping in the General Theory of Relativity. By N. Hu. Pp. 87–112. 3*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1947.) [313

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USE OF THE LAND IN BRITAIN

THE interest in the first annual report of the Local Government Boundary Commission (London : H.M. Stationery Office. 4*d.* net), which covers the year 1946, lies less in the factual account of changes or proposals for change recorded than in the appraisal of local government opinion in Great Britain which the Commission has such a unique opportunity to present in the course of its inquiries. The task of the Commission is to make, so far as is practicable, all local government authorities, both individually and collectively, effective and convenient units. That in itself is an immense task, involving the review of the status and boundaries of 61 counties, 83 county boroughs and 1,356 county districts, and the Commission recognizes frankly that procedure is experimental and that the task can only be accomplished successfully with the active goodwill and co-operation of the local authorities themselves.

Nor is this all. The task is related not merely to that of post-war reconstruction and planning generally. It has implications for many of the measures already enacted or under consideration by the Government, such as the Town and Country Planning Bill, the areas of the regional hospital boards under the National Health Service Act, and the proposals for national parks and Nature reserves outlined in the Hobhouse Report, not to mention the location of industry, agriculture, forestry, and water and power supply.

The decisions thus far announced are mainly negative and incomplete, indicating the kind of proposal that is unlikely to be approved, but not the extent to which changes may ultimately proceed. It will be noted, however, that Plymouth's progressive housing policy has been thwarted, on the advice of the Minister of Town and Country Planning, by the refusal of space for the proper accommodation of half the overspill provided for in the Abercrombie plan. The Commission has here shirked the planning responsibilities which are inseparable from the proper discharge of its responsibilities ; but in general its broad review indicates that the Commission is cognizant of the issues involved in the various types of proposals for change.

Meanwhile, however, the Commission has noted the unanimity with which representatives of rural districts have based their objection to absorption into boroughs on the consequential loss of the parish councils or the parochial committees. On the other hand, the larger towns are frequently interesting themselves in the new conception of neighbourhood units and community centres, and most plans for the development of new estates on the periphery or for redevelopment of central areas provide for such units.

The Commission does well to suggest that these two ideas might be brought into contact. There is real danger that with the need for provision of some services by large and therefore somewhat remote authorities operating over wide areas, the ordinary citizen will lose interest and contact with the local government and the elected representatives of his own locality.

The Commission here touches on one of the greatest dangers in the regional system. It is vital in a democracy to preserve and to extend the means for the expression of local views and for maintaining local interest. The Hobhouse Committee equally recognizes this, insisting on the importance of national control and a national policy for Nature reserves, as did the Dower Report, and that central management and development must be planned from the start in adjustment with other essential interests in the land, such as agriculture, forestry, water supply, communications and building; but the importance of enlisting local knowledge and experience, and encouraging and maintaining local interest and co-operation, cannot be too much emphasized.

The most casual consideration of the relation of the areas of the proposed national parks and of the counties and county boroughs falling within the parks should be sufficient to demonstrate the value of such co-operation and interest; nevertheless, there have been repeated incidents in recent years in such matters as highway development, water supply or hydro-electric schemes or the location of industry which indicate how rash it would be to rely upon unguided local bodies to consider matters from a national or even a regional point of view. There is a most important task of education to be undertaken before democratic planning can become a reality. Political and Economic Planning has already given attention to this matter in a series of broadsheets issued earlier this year. "Active Democracy—A Local Election" (No. 261), "Clubs, Societies and Democracy" (No. 263) and "Public Relations and the Town Hall" (No. 265) all examined different facets of the problem. But a later broadsheet, "The Plan and the Public", which has recently appeared, goes to the heart of the matter; it is of vital interest at the moment not only in relation to local government but also to the issues involved in the present economic crisis.

This broadsheet puts in their proper perspective some of the problems which arise in carrying through the experiment in democratic planning to which Great Britain is committed, and asks some of the awkward questions about our social institutions and attitudes which must be answered if the active participation of the citizen in the planning process is to become a reality. It is a most valuable contribution to the assessment of the task of the new Economic Planning Board, and of the decisions to be taken by the Government as well as of the limitations of Government action. It emphasizes the responsibilities which both the Government and the Opposition must accept, quite apart from that of maintaining an atmosphere of free discussion and criticism. *Planning* does well to direct attention to the large measure of common ground in the economic plan, to the plain fact that an Opposition on coming into power would have to start where the old plan left off, and that the essential co-operation cannot be expected if the Government shows itself reluctant to accept it or if its representatives go out of their way to use phrases calculated to exacerbate hostility. These are timely reminders, no less than the further one that democracy implies the right of the people to discharge planners whose plan fails to operate continuously and genuinely to meet the requirements of the consumer. Leadership, persuasion and effective forethought are essential in democratic planning; without them come threat and compulsion, and there has been evidence at times that we are verging uncomfortably near such a regime.

The broadsheet limits itself to the consideration of the first two of the three elements—consultation, communication and execution—involved in democratic planning. In regard to the first, it directs attention to factors which have weakened the claim of the House of Commons to be the exclusive source of information about public opinion, and reviews the development of consultative machinery, the need for which was stressed in the new planning proposals of the Government announced in March 1947. One of the purposes of the development councils to be established under the Industrial Organisation Act is to facilitate consultation; but as the broadsheet observes it is doubtful whether any better or more representative body than the House of Commons can really be found so far as consumers are concerned, and the logical step would be the devolution of more responsibility on local authorities as custodians of consumers' rights. The need for other *ad hoc* bodies implies a reflexion on the representative character of elected local councils.

The main point brought out by the broadsheet on this question of consultation is that, to be effective, consultation needs to be continuous. Spasmodic reference of a particular Bill or a special problem to an interested group or an advisory body is not enough. Furthermore, *Planning* puts some all-important questions about the nature of such organisations. Are their leaders truly representative of the interests and of the men and women in whose name they speak? How far are they capable of leading as well as listening, of throwing up economic statesmen rather than mere spokesmen of sectional interests? And do they provide effective means for the speedy transmission of views both from centre to periphery and from periphery to centre?

There are wider constitutional issues implicit here, and the fuel crisis early in the present year revealed how serious they may be. It was disturbing to find that the Government attempted, for example, to justify the suspension of periodicals not so much as in the national interest as in conformity with an agreement made with an association representing some of the proprietors of periodicals. Ultimate responsibility must clearly rest with Ministers answerable to Parliament, but equally the Government must use consultative machinery as a real aid to making decisions and softening their impact when made, and not as a pretext for delay and postponement of decisions which it is too hard-pressed or too timorous to make for itself.

Nothing could illustrate this better than the present position of the Service land requirements in relation to the proposals for national parks and Nature reserves, as the continuous stream of criticism of the Interdepartmental Committee shows. A written statement from the Minister of Town and Country Planning on July 29 showed that only four of the twelve areas proposed for national parks are at present free from Service demands. Of the 392,960 acres of North York moors 27,500 acres are held for training and other purposes; 26,000 acres out of 146,560 of the Pembrokeshire coast, 47,500 out of 327,168 of the Brecon Beacons and Black Mountains, 41,600 out of 250,880 of Dartmoor; while since the statement was made a fresh threat has become apparent to the Lake District, where in addition to the 700 acres at present held, a further 10,000 acres in the Coniston area is requested by the War Office. Service departments should not be exempted from the control exercised in the public interest.

These figures take no account of the threats to the numerous areas proposed as Nature reserves, and the whole trend of the reply of the Minister to the question regarding the public inquiry into the proposed Dartmoor training areas indicates the failure of the Government to appreciate the importance of this question of consultation, or that evasion of the issue may endanger the success of the whole experiment of democratic planning. It might even be argued that one factor in our present critical economic position has been lack of effective consultation; and it is certain that the nation as a whole is at present nowhere near possessing either a sufficiently wide and general understanding of social and economic affairs, or a sufficiently disinterested and public-spirited attitude towards them to enable this or any other Government to carry through the immensely difficult task of democratic planning with which we are faced. Nothing less than a sustained and intensive attempt, with a carefully thought-out strategy, to raise the level of public understanding and to change the attitude of ordinary people towards their social and economic responsibilities, will ensure the support on which the Government's plans for meeting the crisis depend for success.

In such a campaign, as *Planning* points out, not merely the Government with its specific publicity organs but also nearly every organised group and institution in Britain will have its part to play. Scientific institutions or associations have their own special contribution, for which they may have to go through a period of trial, adaptation and transformation to enable them to take the new part in public life which an era of democratic planning demands of them.

Looked at broadly, it is a part of the old question of relating knowledge to action, securing the 'climate of opinion' which will permit policy to be framed and decisions taken in accordance with the facts which scientific inquiry has already brought to light. As Sir Oliver Franks has put it, the Government's plans must be made the plans of the nation, so that they are animated by the constructive endeavour of the managements and workers who carry them out.

THE POETS' VIEW OF NEWTON

Newton demands the Muse

Newton's *Opticks* and the Eighteenth Century Poets. By Marjorie Hope Nicolson. (History of Ideas Series.) Pp. xi+178. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1946.) 11*s*. 6*d*. net.

IN 1728 Henry Pemberton published "A View of Sir Isaac Newton's Philosophy", which gave a popular account of the contents of the "Principia" and of the "Opticks". To it the author prefaced "a copy of verses on Sir Isaac Newton, which I have just received from a young Gentleman, whom I am proud to reckon among the number of my dearest friends". The young gentleman was Richard Glover, best known to students of eighteenth century literature as the writer of "Leonidas" and one of the many reputed authors of the "Letters of Junius". In the invocatory lines he exclaims:

> "Newton demands the Muse; his sacred hand
> Shall guide her infant steps."

and it is from this passage that the book now before us takes its title.

Miss Marjorie Nicolson, who is well known to the curious for her studies of the effect of scientific discovery on the literary imagination in times past, sets out to show the great influence which Newton's work, and specifically the publication of the "Opticks", had on the poets of the eighteenth century. In this connexion there are certain names that occur at once to anyone familiar with the period, in particular James Thomson, whose "Poem Sacred to the Memory of Sir Isaac Newton" shows a just and gracefully expressed comprehension of Newton's achievements and whose "Seasons", as Miss Nicolson points out with many examples, also shows a strong Newtonian influence. Thomas Young, of the "Night Thoughts", which was a 'best seller' in its time, and Mark Akenside may, perhaps, also be considered as obvious candidates in this connexion, and they are abundantly cited. These three, however, form but a small part of the company that the author invokes.

Richard Blackmore, best known for his "Prince Arthur", wrote a long poem, "Creation", in which he dealt not only with the "Principia" but also with the "Opticks", showing some misunderstanding of wave propagation, in which Miss Nicolson follows him: John Reynolds, quite neglected to-day —and rightly, for his "View of Death", which had something to say of Newton's discoveries, was, as our author freely admits, insufferably tedious; Moses Brown, who wrote an "Essay on the Universe"; and Henry Brooke, whose "Universal Beauty", judging by the specimens quoted, gave a not very accurate account of certain optical phenomena, were poets who concerned themselves directly with expressing Newton's discoveries, as did, in better poetry and sense, Thomson and Glover. Christopher Smart, Mallett in "The Excursion" and others were content with general rhapsodical descriptions of light and colour. It might be thought at first that this was not all due to Newton's influence, but if one considers the number of direct references to the great man in some of the poets cited, and more particularly if one searches, as I have done, for similar passages in Spenser and other pre-Newtonian poets, one is brought to agree that Miss Nicolson has made out a very good case for her theme that Newton was responsible for the great attention which the early eighteenth century poets gave to light and colour, even when they did not quote him directly.

There are occasional exaggerations, as when Shelley's famous

> "Life, like a dome of many-coloured glass,
> Stains the white radiance of eternity"

is attributed to Newton's prism, for why should the absorption colours of stained glass be termed prismatic? Pope, it is true, refers directly to "False eloquence like the prismatic glass", but it requires some effort to trace a Newtonian influence, as does our author, in the description of the garments and wings of the sylphids, just because of the glitter and colour. In referring to this passage and on other occasions Miss Nicolson speaks of light being refracted into colour, as if all colours, including in particular the scattering colours of cloud and mist, were refraction colours, a misunderstanding which possibly some of the poets have shared, but which the critic might well avoid.

In the last chapters of the book, which deal with the metaphysical implications of the "Opticks", Miss Nicolson rather deserts her main theme to consider the effect of Newton's cosmogony on his more materialistic disciples and the reaction of the school of Pope against those who thought that the road to all truth lay through experimental science. The book concludes with a very interesting consideration of William Blake's violent attacks on his antipathies, Bacon, Locke and Newton, whom he grouped together as doubters and unbelievers. "God is not a mathematical diagram" expresses his reaction in one sentence.

It is strange to find that one so well read in the eighteenth century as Miss Nicolson should suppose that when Newton wrote "I intend to be no further solicitous about matters of Philosophy" he meant by philosophy what we mean nowadays. He had in mind, of course, what we now call science, as is quite clear from, for example, the celebrated "Philosophy is such an impertinently litigous lady" letter, and from the very title of Pemberton's book, quoted at the beginning of this review. Miss Nicolson, on what ground I know not, says that "he would have preferred the proud title 'theologian' to that of either 'philosopher' or 'scientist'"—he could scarcely have contemplated the latter title as the word was not, so far as I know, used until 1840 or so. What she means by saying that ever since his death Newton has been considered a metaphysician I cannot conjecture. Nobody ever stated more clearly than Newton what he was trying to do in the "Opticks", the book with which she is particularly concerned—"My design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove them by Reason and Experiments". There is not much metaphysics there.

The book, which throws a novel light on an interesting aspect of the eighteenth century temperament and tradition, is likely to appeal to a wide range of scholars, scientific, literary and philosophical. It is all the more a pity that the references, which are copious, are given in so unsystematic a fashion. Whatever else is added, the first edition should always be quoted, if only to give the date of the original appearance, but this is seldom done, nor does there seem to be any rule as to which edition is selected, the earliest or the latest. Sometimes for the same poet, in different places, the reader is referred to a first edition, to Chalmers' collection, to Johnson's collection, and to an unspecified edition. In the case of long poems there is often no indication as to where a passage quoted is to be found. Strangest of all is a reference for Voltaire's poem, addressed to Madame La Marquise du Chatelet, namely, to the "Oeuvres Complets de Voltaire" of 1785. This poem was prefaced to Voltaire's "Elémens de la Philosophie de Neuton" which appeared in 1738 and went through several editions, contributing largely to the popularization of Newton's work. An English translation, by Hanna, which includes the poem in question, appeared in the same year as the French original. It would scarcely be worth while mentioning these matters if Miss Nicolson's wide reading and scholarship did not make them surprising. In any case, they do not diminish the warmth of our welcome to this unusual and entertaining study of Newton's influence. E. N. da C. Andrade

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MECHANICS OF ROAD-MAKING MATERIALS

Soils, Concrete and Bituminous Materials

A Record of a Course Dealing with Airfield Construction given at the Road Research Laboratory, Department of Scientific and Industrial Research, July–August 1943. Pp. 288. (London: H.M. Stationery Office, 1946.) 10*s.* net.

MORE than twenty experts in soil mechanics, concrete construction and road engineering have contributed to this valuable record of lectures, dealing with the problem of designing and constructing runways under the great variety of conditions encountered during the War in all parts of the world. A large proportion of the lectures outline various theories of soil mechanics in regard to the capacity of the ground to support load, in order to show how laboratory and field tests can be used to predict the behaviour of the ground under load. Of these, load-settlement curves obtained for small test areas of ground, suitably adjusted for full-scale loading and moisture conditions, would appear to be the soundest method of obtaining safe values of the modulus of soil reaction which, together with the tensile and elasticity characteristics of the concrete, determines the thickness of the latter in the form of a road slab, required to support a given point load. Methods of improving the condition of the sub-grade by drainage, soil stabilization and consolidation are described in detail. A full account is given of the procedure of grading local aggregates and controlling the ratio of water to cement in order to produce the strongest concrete. The use of special devices such as steel mesh tracks on sandy surfaces and blasting in swamps are described, and a whole section is devoted to tar and bituminous surfacing and soil stabilization.

One chart is supplied giving some indication of the values of the sub-grade modulus for various kinds of soil. This is gratifying, as values of this factor, which covers the principal soil mechanics data required by foundation and road engineers, have so far only occasionally been published. Records of the settlement of oil tanks which have flexible bases and cover a large area of ground are probably the best source from which to obtain this valuable information.

No method of designing highly reinforced and flexible concrete road slabs is given. Assuming soil reactions to vary in accordance with a straight-line law greatly facilitates calculations of this type and is justified in view of the vagueness of sub-grade modulus values. It is, then, simple to take into account, and use to the greatest advantage, slab flexibility in reducing bending stresses.

The publication of these lectures provides the road engineer with most of the practical details he requires in regard to recent developments in road and runway construction, both in the United States and Great Britain, and also a theoretical background in regard to soil mechanics, enabling him to relate the results of laboratory tests to the strength of the sub-grade and road slab in supporting wheel loads. Dr. Glanville, his staff and the various lecturers who contributed, are to be highly congratulated on a work which will be of great value to road engineers in all parts of the world.

STAR POSITIONS

Apparent Places of Fundamental Stars, 1947

Containing the 1535 Stars in the Third Fundamental Catalogue (FK3) of the Berliner Jahrbuch. (Published by Order of the Lords Commissioners of the Admiralty.) Pp. xxxii + 538. (London: H.M. Stationery Office, 1946.) 42*s.* net.

UNTIL 1940 each of the principal almanacs in various countries published the apparent places of a different selection of stars, the places of which were not even always referred to the same fundamental system. In addition, the number of stars for which the apparent places were given in any one almanac was insufficient. As a result of discussions at the International Astronomical Union in 1932, 1935 and 1938, it was decided that the Third Fundamental Catalogue of the "Berliner Jahrbuch" should be used as the fundamental catalogue for apparent places of stars in all ephemerides. It was further recommended that the apparent places of all the stars in that Catalogue should be published in a single volume, the calculations being carried out by France, Germany, Spain and the United States, Great Britain undertaking the printing. The first volume appeared in 1941, and subsequent issues have retained practically the same format except for temporary omissions owing to war-time difficulties. The late appearance of the 1947 volume, which should have been published in May 1946, is exceptional.

The introduction is printed in four languages—English, French, German and Spanish—and provides full explanations with examples of the use of the different auxiliary tables, together with a list of the corrections applied for parallax and orbital motion.

The first section, comprising 34 pages, gives the mean places of all the stars (1947·0) with their annual variations, proper motions and mean errors. The next and largest section contains the apparent places, at upper transit at Greenwich for every ten days, of 1,483 stars the declinations of which lie between ± 81°. First differences are given for each co-ordinate to facilitate interpolation, and at the foot of each page is subsidiary information on mean place, mean error, secant and tangent of mean declination, etc. Section 3 gives the apparent places, for every upper transit over the Greenwich meridian, of fifty-two stars lying within 9° of the two celestial poles. These include the effect of short-period terms of nutation, and subsidiary information is provided. Section 4 contains short-period terms of nutation in longitude and latitude, mean and apparent sidereal time, at 0^h, tables for converting mean solar to sidereal time and vice versa, and also for converting hours, minutes and seconds to decimals of a day, corrections to a linear interpolate for the effect of second differences, and corrections for diurnal aberration. The last section gives an index to the apparent places of stars, and many of them are given more than one name to facilitate the search for their positions.

This publication will naturally find a place in every observatory engaged in fundamental observations. It will also prove very valuable to institutions engaged on accurate surveys, for which there is not sufficient selection of stars in the almanacs. M. DAVIDSON

SCIENCE IN PROGRESS

Science in Progress

By Frank B. Jewett, James B. Macelwane, Donald W. Kerst, Hugh S. Taylor, L. Michaelis, Michael Heidelberger, G. W. Beadle, Peyton Rous, E. C. Stakman, Carl Caskey Speidel, Herbert M. Evans. Edited by George A. Baitsell. Fifth Series. Pp xv + 353. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1947.) 5 dollars.

THE fifth series of "Science in Progress" contains reports by ten leading American men of science in their respective fields and an introduction by Frank B. Jewett, president of the National Academy of Sciences, on "The Future of Scientific Research in the Post-war World". He has estimated the effect of the War upon "fundamental and applied science and scientific manpower". His plea is for a reconsideration of the scope and importance of fundamental research. A mere beating of swords into ploughshares is only a part of the problem. He is particularly impressed by the increasing use of team-work and mathematical machines in scientific research. For the most part all the chapters in the specialized fields can be followed by any reader with a grammar school scientific training.

Some of the chapters are noteworthy as models of thorough, scholarly yet simple treatment. Of these, D. W. Kerst's account of the development of the betatron, H. S. Taylor's history of contact catalysis between the two World Wars, G. W. Beadle's chapter on genes and the chemistry of the organism, and Peyton Rous's essay on the cancer problem are particularly outstanding for their directness and clarity. Rather more technical in style, but masterly and up to date, are the chapters by J. B. Macelwane on the interior of the earth and seismology, by L. Michaelis on oxidation and respiration, Michael Heidelberger on serological complement, E. C. Stakman on the difficulties of dealing with plant diseases, and Herbert Evans on hormones. The last, containing such sentences as "hepatic gluconeogenesis which adrenal cortical hormones characteristically produce", may make hard going for the layman in physiology. By contrast, the description given by C. C. Speidel of the cinephotomicrography of living cells in action makes easy reading.

It is to be hoped that Yale University Press will continue to issue such annual accounts of recent work in science. The general production of the book may make British readers rather envious of the qualities still maintained in the United States.

W. L. SUMNER

EDUCATION OF THE MAN OF SCIENCE

By Sir JOHN LENNARD-JONES, K.B.E., F.R.S.

LARGELY as a result of the War, there is now wider recognition of the possibilities of science and the powers of the trained man of science. This is reflected in the growing interest of contemporary literature in scientific affairs and in the frequency with which the opinion of scientific workers is sought on major matters of State. This improved status of science can only be maintained if men of science adopt a greater sense of responsibility; for the searchlight which is focused on them will necessarily expose their limitations as well as their strength. It is fitting, therefore, that at this time men of science should subject themselves to a searching inquiry of their training and qualifications. No place could be more appropriate as a forum for such a discussion than a meeting of the British Association, where all branches of science are represented and where so many sections of the scientific community assemble. At the recent meeting at Dundee a general discussion, supported by all the sections, took place on "The Education of the Man of Science" and attracted a large and representative audience.

The importance which the British Association attached to the discussion was indicated by the presence of the president, Sir Henry Dale, in the chair. The principal contributors included the headmaster of one of the best-known day schools of Britain, a university professor of the first rank, an eminent industrial scientific worker, and a vice-chancellor of a university famous as a centre of culture and learning.

As often happens in a discussion of such a broad topic as the education of men of science, there was no precise definition of many of the terms used. The term 'man of science' is often used to connote a member of that small but highly distinguished band of investigators who lead in the paths of discovery. To others it means one of that large body of scientific craftsmen, who, having had a university training in science, earn their livelihood by the pursuit of science or the application of science, whether in the universities, or in industry, or in Government laboratories, or elsewhere. It is necessary to distinguish clearly between the needs of the specialist, and the needs of the average scientific worker. The methods in use at the schools and universities of Britain have in the past created scientific leaders of the first magnitude, and the virtues of such a system cannot be lightly discarded. On the other hand, it may well be argued that the courses designed primarily for specialists are not necessarily well suited to the needs of the body of scientific workers of more average ability.

Scientific workers of the first rank are usually men of wide interests and cultural attainments. Nothing could be more specialized than the present training of mathematicians, and yet the ablest of them are often men of great literary ability. Eddington and Jeans were outstanding examples. In every branch of science there have been leaders who have attained distinction, not only in their subject, but also in the art of lucid and concise exposition.

It may be instructive to inquire why it is that the man of science of the most gifted kind is also usually a man of culture, for this may help in considering the education of those of more limited talents. Having ability of an unusually high order, with all that that implies of alertness of mind, quick understanding and capacious memory, he develops as a rule wide and intense interests. It may be that these are associated with, or arise from, his predominant life's work, but all life, all Nature, arouses his penetrating curiosity. Finally, being quick in thought and efficient in action, the greatest scientific worker contrives also to have leisure. The qualities of ability and interest, together with leisure, lead to a fund of general knowledge and culture which we describe as education; and perhaps it is the gift of ever-widening interest which matters most.

Implicit throughout the discussion was, however, the assumption that it is the education of the good, competent, but not exceptionally brilliant man of science which gives cause for concern. In this category we may include all who are professionally engaged in the pursuit of science, whether in teaching, or in research, or in the manifold applications of science to industry.

Education is a more difficult term to define. It is easier to say what it is not. It is not simply the acquirement of knowledge or the filling of the mind with facts, or even familiarity with a particular culture. It may be more an attitude of mind or the habits of thought engendered by study, or again it may be a cultivation of personal aptitudes and abilities to enable a man to live a useful and satisfying life. Sir Henry Dale in his opening remarks said that education should provide not only a training adequate for the technical needs of a man of science in his profession, but also should fit him for his part as a good citizen and an acceptable member of a cultured community. He stressed also the importance of the power of communicating thought and the discipline of lucid and accurate composition.

The point of view of the schoolmaster was expressed by Dr. Eric James, the High Master of Manchester Grammar School, who said that the task of the schools is a threefold one: first, to maintain the quality of the specialist knowledge of our potential scientific workers; second, to see to it that they are aware of the social relevance of their work; and third, to ensure that they are people with the fullest general education. He was of the opinion that a man who has specialized in one science at a university, and perhaps done some research in it, is usually a better teacher not only of that but also of other subjects than one who has attempted to bring several subjects to degree standard. Moreover, he has often had leisure for interest in other subjects, which have contributed to his wider education. He thought it was no answer to the problem of providing a general education to insist that all men of science should reach a certain standard in a literary subject; in, for example, a modern language. What is required is imaginative teaching of such subjects as history, divinity, or even elementary philosophy, so that the boy or girl should be led to think and read and argue for himself.

Sir Lawrence Bragg described the kind of training which science students receive at present in British universities and said that, while a large proportion of science students leave the university at the completion of a three- or four-year course, many of those adopting science as a profession now spend a further three years in research, so that the total time spent at a university may be six or seven years. The object of the university course should be to train a student in certain fundamental mental disciplines, so that when later in his career he is confronted with new problems, he may fall back on the old lines of thought and use the conceptions he has acquired, even though most of the factual information he learned may have been forgotten. In many respects university courses had in the past been successful, particularly in providing leaders in pure science, but serious criticism has been advanced that the present generation of scientific workers has had too narrow and specialized an education. It is also a frequent complaint of the industrialist that scientific recruits are unco-operative and intolerant and lacking in a knowledge of the world.

Sir James Irvine thought that some of the defects of the present method of training could be overcome, or at any rate mitigated, during the post-graduate years, particularly if there was the right relation between student and supervisor. It was a time to fill in gaps in education both on the scientific and literary sides. The writing of scientific reports could be made an important part of the education of a scientific worker. He favoured the study of a language, preferably Latin, to assist in the art of writing and speaking the English language. He also advocated an interest in poetry as a stimulus to the imagination and a counterweight against materialism.

The point of view of a man of science in industry was expressed by Sir Arthur Fleming, who dwelt on the qualities of mind and character which, in addition to technical proficiency, are necessary for success in industry. He mentioned qualities of sound judgment, courage and the capacity for leadership. He made the point that a considerable number of science graduates who enter industry ultimately change from purely technical work to other tasks, where their scientific training, while still of importance, becomes secondary to other qualities. Reference was made to a recent survey of more than a thousand science graduates who had passed through the post-graduate training scheme of a large engineering firm. It was found that at the age of thirty-five, fifty per cent of the men were no longer engaged primarily in technical work, while at the age of forty-five the proportion had risen to more than seventy-five per cent. This means that it is important for the ordinary science graduate to possess, or to develop, the qualities which will enable him to fit into the important and responsible positions, open to scientific workers, offered by a large industrial organisation.

In the open discussion which followed, a representative of the Scottish Branch of the Science Masters' Association stressed the importance of training character as well as developing technical skill. He said that since ideals are more readily caught than taught, it is necessary that university science graduates of the highest quality should enter the teaching profession. Universities should encourage a proper balance in schools by limiting the knowledge demanded of entrants and should take character into consideration.

Reference was made by Dr. Maxwell Garnett to the work of a committee of the British Association on university education and to the need for an inquiry in Britain similar to that which had produced the Harvard report on "General Education in a Free Society".

There seemed general agreement among all those who contributed to the discussion that all is not well with the education of the man of science; but where precisely the defects lie, or what the remedies should be, are matters on which there are conflicting opinions. If the objectives were agreed, the means would not be lacking to attain them. Part of the difficulty arises from the differing views as to what constitutes education. There is often confusion between education and the acquirement of knowledge. As was pointed out by Dr. Eric James, there is a tendency to assume that a general education can be obtained by a suitable arrangement of the school time-table. He was surely on the right lines in stating that the aim should be to introduce to boys at school some of the problems of life and society in such a way that they will want to read and think and argue for themselves. In other words, we should try to promote their interest in the wider field of knowledge by using as a central nucleus the scientific knowledge they already possess. Could not history—and in some cases literature—be taught from this angle ? Social history is as fascinating to the scientific worker as to the historian, and in this respect Trevelyan's recent book provides an admirable example of what can be done. This approach to history provides contacts with daily life and experience, and shows the effect of discoveries in science on the daily lives of mankind.

Everyone seemed agreed that a reasonable competence in the art of self-expression, both of an oral and a written kind, should be regarded as a necessary qualification of a man of science. This implies wide reading and a rich vocabulary, so that ideas may be expressed clearly and vividly in simple language without an excessive use of technical jargon. But, as Sir Henry Dale said, before we put too exclusive a faith in extra scientific studies as the means to this end, we ought to consider whether present faults may not be mainly in the teaching of science itself. The power to give clear and simple expression to a result or a conception requires, in the first place, the ability to think clearly about it; and teachers of science have admirable opportunities of training their pupils in the art of expressing what scientific knowledge they possess. Science can provide many examples of men who without the advantages of a formal education have produced writings on science which are none the less admirable as literature. The teaching of science can be made in itself cultural.

The discussion brought out that other traits of mind and character are necessary for success in the active and developing fields of scientific endeavour. How are qualities of sound judgment, courage or leadership to be developed in the course of education ? To some extent they are probably innate and can only be developed and fostered by training. Judgment involves experience and the capacity to profit by experience. Leadership involves self-confidence and the ability to inspire others. These qualities are not likely to be engendered by study but more by contact with affairs and association with one's fellows.

Education must accordingly provide for social contacts on an adequate scale. Schools and universities cater in differing degrees and with differing success for these requirements. There is a widespread feeling that fuller facilities for residence in the universities are a necessary development to meet this need. The severe selective competition of the class-room tends to produce intense individualism. This often becomes more pronounced in post-graduate work, when there is an understandable eagerness to make individual contributions to the field of knowledge and a corresponding desire for personal recognition. It is all the more necessary that there should be counterbalancing influences in a well-ordered communal life for undergraduates and post-graduate students. We have to reconcile the virtues of individualism with a spirit of co-operation, for excessive individualism may lead to difficulties in a large organisation.

The education of the man of science must be such that it gives him points of contact and common interest with his fellow men, and at the same time permits him to reach forward to the limits of knowledge in his own field. In this sense it must provide ever-widening expansion in the horizontal plane, the plane of general experience, and at the same time provide the path to the heights of specialist knowledge.

The discussion directed attention to important problems. It raised more questions than it answered, and these are the concern of school teachers, university teachers and industrial scientific workers alike. There is need for closer consultation between all the principal parties concerned. The discussion arranged by the British Association will have achieved its purpose if it stimulates further exchange of views and leads to the setting up of competent, representative bodies to study the problems involved. Thus may we hope to advance along the road of educational progress for the benefit of the next generation of men of science.

UNIVERSITIES OF GREAT BRITAIN

THE "Conference of Home Universities", which met in the Senate House of the University of London on September 26 and 27, was the second which had been called together at the initiative of the Vice-Chancellors' Committee. The first conference, which took place in 1946, was of a tentative nature (a report has just been issued: Universities Bureau, 8 Park Street, London, W.1. Pp. 76. 1s.); but the present meeting was on a larger scale and had a wider range. Its purpose was to test the value of discussions between the administrative authorities of the universities and the representatives of the teaching staffs, on questions affecting the policy and the development of university education. It was attended by pro-chancellors, vice-chancellors, principals and by representative professors and lecturers from all the universities and university colleges of the United Kingdom, by members of the University Grants Committee and by representatives of the Association of University Teachers and the Scottish Association of University Teachers.

Such a gathering may legitimately claim to be a model or blue-print, or whatever the current phrase is, of a university parliament. When one considers the independent origins of the universities of the United Kingdom, their diversity of age and constitution and their jealously guarded tradition of autonomy, it is a step of no small importance to higher education that they should thus assemble the various elements in their hierarchies to discuss problems of the day which affect them all in common and may influence their future.

Some may be tempted to regard such an undertaking as another manifestation of the passion for planning, from which few interests are to-day immune, but that would be a complete misunderstanding of the spirit and intention of the Conference. There was no suggestion of any move towards uniformity, nor even of any special expectation or wish for unanimity. Everyone concerned recognizes that each university must continue, as in the past, to work out its own salvation in its own way, but these conferences may enable it to take advantage of the benefits of consultation and the pooling of experience, in which lie the true strength of democracy.

The first session was devoted to the question of "The Expansion of the Universities". The chairman was, appropriately, Sir Alan Barlow, second secretary of the Treasury and recently chairman of a Government committee the report of which, urging an increase in the output of scientific workers by 100 per cent in the next ten years, has aroused so much interest and controversy. The vice-chancellors have themselves issued a commentary on this report, demonstrating the difficulties which stand in the way of expansion on such a scale, and Dr. R. V. Southwell, rector of the Imperial College of Science and Technology, dealt with some of these in his address. He believed, he said, that the two major questions around which most of the discussions on the Barlow Report had centred were at present insoluble. These were: (*a*) the extent of the demand from industry for university graduates; and (*b*) the reserve of intelligence of university level available to increase the number of graduates. He considered that material shortages would, in any event, preclude undue expansion in the immediate future, and that we might beneficially confine our discussions to certain non-material questions with which a policy of expansion confronts us, and which must be resolved if expansion is to take place. He instanced the maintenance of academic standards, the balance of subjects in the faculties and the task of the universities in technology.

The discussion which followed tended to emphasize the present material difficulties; but Lord Simon of Wythenshawe and other speakers agreed with Dr. Southwell's conviction that university training of men of science and technologists is an essential part of the production drive and that it must rank among the highest priorities if production is to flourish. Lord Eustace Percy (Durham) pointed out that some universities have already gone so far in permitting expansion that unless greater Government support be forthcoming they would be forced to reverse the movement.

Prof. R. Pascal (Birmingham) directed attention to the importance of the balance of studies, and urged that expansion in the arts faculties should be governed by an authoritative estimate of the demand for their graduates, if we are to avoid the evils of over-production in that direction.

The second session turned to the question of "The Basis of Selection of Students", under the chairmanship of Prof. F. C. Bartlett, professor of experimental psychology at Cambridge. The discussion was opened by Prof. Godfrey Thomson of Edinburgh, who brought forward arguments based upon intelligence tests, which tended to show that the university population could be doubled without a fall in standards, provided that all those of adequate intelligence outside the universities could, in fact, be brought in, and that efficient selection were operative. He presented the detailed results of a number of investigations; but was careful to emphasize the somewhat precarious nature of the data. He also recognized that there is a fairly large percentage, among those of adequate intelligence, who do not want a university education and would refuse it even if liberal financial assistance were provided.

Dr. J. F. Mountford, vice-chancellor of the University of Liverpool, followed with a consideration of the technique of selection of students. He pointed out that any technique of selection must operate against a background of theory respecting the kind of persons we want in universities and of information about the national requirements, both of which are lacking. He reviewed the value of examinations, recommendations, school records and intelligence tests as means of selection and showed that all are faulty, though he suggested that more use might be made of a carefully devised system of school recommendations, in regard to which we might learn something from American practice. Interviews, while sometimes useful, are tricky and are impossible where very large numbers are concerned. Dr. D. R. Pye, provost of University College, London, gave an interesting account of a system of intelligence testing, requiring relatively little time, which has been experimentally adopted for medical entrants at that College. The chairman stressed the widespread use of intelligence tests, apparently successfully, by American universities.

The final session, under Sir Hector Hetherington, vice-chancellor of the University of Glasgow, considered "The Proposal to Establish a Representative Universities Council". The discussion was opened by Lord Simon of Wythenshawe, chairman of the Council of the University of Manchester, who pointed out that a powerful dual planning organisation, in the University Grants Committee and the Vice-Chancellors' Committee, is already in existence, with a good record of work accomplished. He put the question: What would be the functions of the new body? Prof. S. Brodetsky (Leeds) and Lord Chorley (London School of Economics), on behalf of the Association of University Teachers, both supported the proposal for a new council, which would include representatives of the university teachers and hence might have a realistic approach to its problems. Some apprehension was expressed by other speakers lest the council should trespass on the liberties of the universities, and Sir Walter Moberly made it clear that the University Grants Committee did not welcome the scheme. The chairman then ably weighed up the arguments and concluded by advising that there should be a continuation of these annual conferences, perhaps associated with preliminary regional conferences, rather than a new body. With this suggestion the Conference concurred.

The overall picture drawn by the Conference, of the universities of the United Kingdom between the upper millstone of Government pressure to expand and the nether millstone of crowded entries, creaking with overstrained machinery and ringed by shortages, was not encouraging, and showed how much need there is for the continued consideration of their situation by representative conferences.

The criticism might be levelled at this, as at many other conferences, that there was a tendency to skate round the fundamental issues, and Prof. Bartlett's challenge to consider the type of man we want to turn out from the universities was unanswered. The Conference was not ready for it; but, after all, it is still in the experimental stage, and greater experience will no doubt bring greater potentialities. Practical-minded people expect workaday results in the form of resolutions, appeals, protests and the like; but these things, whatever value they may have, are not to be looked for from a conference the first aim of which is the free exchange of ideas between men of common interests, who would never otherwise meet together. In fulfilling that aim the experiment may be pronounced successful, and we may look with hope for its further development.

Grateful thanks were expressed to Mr. J. F. Foster, secretary of the Universities Bureau, who organised the Conference, and to the University of London, which was host for the occasion.

R. C. McLean

CLEANED PICTURES AT THE NATIONAL GALLERY

By Dr. H. J. PLENDERLEITH

The Exhibition of Cleaned Pictures (1936–47) which opened at the National Gallery on October 9 is of unusual interest. Some seventy odd masterpieces are exhibited and all of them have been cleaned since the autumn of 1936. They are displayed for the first time without glass, on clean walls with auxiliary fluorescent illumination. Documentation is made available relating to the history of the pictures, in particular to their preservation and to any new facts revealed by cleaning: there are photographic records, studio reports and, from the laboratory, radiographs and scientific data collected in the course of diagnosis or for the purpose of making permanent records before, during and after cleaning.

The exhibition is served by a catalogue which explains the conditions in detail. The foreword by the Director of the National Gallery sketches the history of the national collection and shows how cleaning policy has varied since 1824, the date of foundation; and it outlines the main controversies (three in number) which have arisen on the subject of picture-cleaning during this time. In 1853, a Select Committee of Enquiry of the House of Commons put an end to the evil practice of applying to the pictures a varnish containing boiled oil. This varnish on ageing provided the golden colour which has too long been considered in the public mind to be the stamp of an old master. The old masters themselves have something to say on the matter—Rubens, Hogarth, Reynolds and Constable. They appeal with one voice for the protection of their works against whatever factors cause the yellowing of paint, and in doing so place a serious responsibility on posterity.

The exhibition is frankly experimental in character. While picture-cleaning is the central theme, the opportunity has been taken to stimulate interest in other aspects of practical curatorship. The visitor is introduced to some of the problems of preservation, storage and exhibition as they exist in the post-war National Gallery, and led to appreciate something of the care and control that goes into the safeguarding of our national patrimony of art.

Picture Cleaning

For many, the idea of cleaning pictures must be novel. It arises generally from the necessity of removing old varnish which has become yellow, shrunken and hardened, in which condition it causes a misrepresentation of the original colour and promotes cracking and the eventual disintegration of the underlying paint film. There is general agreement that the cleaning of pictures in the interests of their survival is an unfortunate necessity. Cleaning is followed by restoration, and this may mean anything from spotting out lacunæ caused by the flaking of old paint, to replacing a rotten canvas or panel by a fresh support. After restoration the picture has to be re-varnished, and this is carried out with the two-fold object of protecting the surface and of bringing the optical quality of the work, so far as possible, to the key intended by the author of the painting.

The resin selected for making picture-varnish is exclusively mastic: this is dissolved in turpentine without the application of heat. A coat of mastic varnish may remain protective for about fifty years under museum conditions, by which time it usually requires replacement. It will seem strange that such an impermanent varnish is preferred, and there is undoubtedly need for research in this direction. The advantage of mastic is that, irrespective of its age, it can be removed, with ease, by solvents which have no softening effect on the underlying paint film—a fundamental requirement of any varnish designed for artistic purposes. No permanent varnish is as yet known which possesses this property and is satisfactory in other respects.

During the present century, the incidence of cleaning at the National Gallery has been very irregular. For a variety of reasons, less than one picture a year was cleaned between 1900 and 1933, and thus there are large arrears of work requiring urgent attention. The war years during which the pictures were in exile provided an excellent opportunity to make up leeway with the minimum of inconvenience to the public. But it has been possible to treat only the most urgent cases: arrears of cleaning still continue to give rise to official concern.

Standard of Criticism

"The purpose of the exhibition," states the catalogue, "is not only to do justice to the cleaned pictures, but by extending the knowledge of their condition to bring about a higher standard of criticism." It is recognized that public criticism is important to the vitality of any picture gallery; and thus the present exhibition, while providing data for a reply to points of controversy which have been raised in the Press, is designed at the same time to stimulate interest in technical matters and to encourage criticism to develop along constructive lines so that its highest aims may be served.

Can controversy be avoided, it may be asked, when the issue is one of both fact and feeling, condition and appearance, and where there must be, inevitably, ample ground for antagonistic points of view? The answer is that it certainly cannot, and this is, perhaps, all to the good. But in the special case where criticism depends upon incontrovertible fact, whether ascertained or ascertainable, the fact must be recognized and accepted by the critic, otherwise his criticism falls to the ground and does credit to no one.

The significance of the present exhibition is its contribution to factual evidence: we have, in this age, methods of recording facts and of non-destructive testing either undreamed of in a previous generation or refined to the extent of being precision instruments in the hands of the expert—methods of collecting data which can be used in turn for testing the validity of criticisms, or for revealing imperfections in the technique of cleaning and restoration. It is a large step from the 'make do and mend' policy of 1824 onwards to the techniques advocated by the International Conference of Museum Experts, Madrid, 1934[1]. If one studies the history of conservation, one must be impressed by the far-reaching developments in both diagnosis and treatment. Unless criticism is prepared to advance in sympathy, it must lose, inevitably, in significance.

Scientific Inquiry

In the present age, the laboratory is as important to curatorship as is the library, and the National Gallery is fortunate in possessing a laboratory well-equipped for physical investigations, and already of international repute; and shortly to be extended in scope so that chemistry can also play its part and make contributions to the preservation and study of paintings. The value of the laboratory lies in the objective character of scientific inquiry.

For example, allegations concerning damage to Rubens' "Chapeau de Paille" were shown to be fallacious by the microscope and micrometer. Small passages of greenish-blue colour alleged by a critic to be all that remained of Rubens' original background (which, it was suggested, had been removed by drastic cleaning) were shown to underlie the main blue background by at least 0·02 mm., thus vitiating the suggestion. Rubens had overpainted this greenish-blue to eliminate much of the green; but this, of course, could not be appreciated until, in the course of cleaning, the removal of yellowed varnish allowed the eye to differentiate between blue and greenish-blue. The change in appearance is merely the revelation of truth. More is now known of Rubens' technique, and a certain mental adjustment is required to bring this latest phenomenon within our conception of Rubens' studio method. When the facts are digested, parallels are discoverable in other work by the same master, as the catalogue points out.

The value of soft X-rays in the study of painting is demonstrated by the quality of the radiographs on exhibition. Changes in colour can be followed by readings taken on a tintometer: cleaning swabs can be spectrographed or submitted to chemical analysis; and photographic recording by ultra-violet or infra-red illumination or by the use of coloured filters can add still further to the stringency of the control of cleaning operations. Photo-micrographs and -macrographs play their part.

Cleaning and Restoration, Good and Bad

A photograph of the forehead of the (restored) Velazquez "Philip IV", taken at about × 4 diameters, is shown in the exhibition. On comparing this with a similar photograph of the picture after cleaning and before restoration, it is clear that many tiny lacunæ have been 'in-painted', that is, restoration paint has been prevented from overlapping the original. The work is done superbly well: the art of restoration has developed with the means of controlling it. In former days over-painting of damaged areas was the rule (compare photograph of the forehead of "Philip IV" before cleaning); and it was even the case that coloured varnishes (anathema to-day!) gratified the æsthetic senses of our predecessors. It need scarcely be said that tinted varnishes were much in favour with the dealer and restorer, in their time, as they served to conceal imperfections of condition and technique.

In some circles the idea still persists that in cleaning a picture there is a positive virtue in avoiding the complete removal of the old varnish, this being claimed as a mild form of treatment. It is a specious argument, and the practice is only in favour in commercial *ateliers* where saving in cost is a factor or where there is lack of confidence or ability on the part of the restorer. It is to be condemned for the following reasons. First, because the use of feeble solvents necessitates using friction, and the rubbing of the surface of the painting tends to remove ridges of paint in the brush-work or crackle system. The hollows of the impasto and the cracquelure tend, inevitably, to become filled with a brown residue consisting of the least soluble constituents of the old varnish. There is this, also, to be said, that a picture so treated will speedily darken to the point of requiring re-cleaning, and the net result is that the incidence of cleaning is increased. Residues of the old varnish may well promote crystallization of the new. The practice of treating pictures along these lines cannot be too strongly condemned. One admits, however, with reluctance, that circumstances may occasionally require a compromise to be made. When this is so it can only be in favour of dark passages of colour: from light pigments and bright colour, all of the old varnish must be completely removed, and the degree of success of the operation can be followed in the laboratory by examining the painting under screened ultra-violet illumination, when the old resin residues are seen to fluoresce unmistakably.

Atmosphere and Stability

While pictures are re-conditioned by cleaning and restoration, their preservation is entirely dependent on the conditions of humidity and temperature in the picture gallery.

When humidity and temperature are uncontrolled, the day and night changes occasion rhythmic movements in the panels and canvases. These may be slight; but in the aggregate they have a deleterious effect on the stability of the paint layer. A consequence is the appearance of blisters in the paint, caused usually by cleavage between the ground and the support, and in the course of a year many are discovered and 'laid' by competent craftsmen. If undiscovered, the next stage is fracture and exfoliation of the paint, necessitating more serious treatment. Extreme atmospheric conditions or changes of condition are liable to cause catastrophe, such as disruption of the constituent planks of Holbein's "Ambassadors" panel (February 1895), or the splitting of Rubens' great "Château de Steen" (January 29, 1947).

It took experience of the war-time repository to bring out the fact that under controlled conditions of humidity and temperature ('conditioned air') no blisters form; there was practically no maintenance work of this kind required at Manod Quarry[2] in the course of years. The moral is obvious and of the greatest significance to the preservation of paintings: conditioned air must be accepted as essential for picture galleries. In the national collection, which is so rich in large Italian panels, a grave responsibility rests upon all who realize what is at stake. This is understood and accepted by the authorities, who, with the help of the Ministry of Works, have improvised a 'hospital' behind the scenes, and here by the aid of primitive controls the relative humidity can at least be held in check. By this means a floating population averaging some thirty 'ailing' pictures is saved, temporarily, from exposure to the more extreme climatic conditions of the public galleries.

It is with relief that we learn that a scheme for installing conditioned air in the National Gallery is in being. The apparatus exists already on the site. Plans have been approved for the first experimental section, and we can look forward to the coming of an era—let us hope it may be soon—when the building will be worthy of its great collection of pictures, cleaned by the enlightened methods of to-day, so that all in their generation may enjoy the work of the old masters as they themselves would have wished.

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[1] "La Conservation des Peintures" (L'Institut International de Coopération Intellectuelle, Paris, 1939).

[2] Rawlins, F. I. G., *Nature*, 151, 123 (1943).

HYPOTHETICAL ALTERNATIVE ENERGY SOURCES FOR THE 'SECOND MESON' EVENTS

By Dr. F. C. FRANK, O.B.E.

H. H. Wills Physical Laboratory, University of Bristol

In the paper by Lattes, Occhialini and Powell*, it is shown that cosmic ray mesons coming to the end of their track in a photographic emulsion rather frequently give rise to a secondary meson of kinetic energy about 4 MeV., and no other visible particle. This observation appears to demand for its interpretation the existence of two sorts of meson, the source of the observed kinetic energy of the secondary residing in the mass difference between the two. In view of the importance of this conclusion, we have tried to consider all reasonably imaginable processes to explain the observations without introducing a new elementary particle; processes, that is, in which the energy is derived from the material of the photographic emulsion instead of from the meson. Reasons are given below for the confident rejection of all such processes.

It is concluded that there is no energy to be gained, from elements present in substantial quantity in the photographic emulsion, from the following processes:

(*a*) Induced β- or K-capture processes; on grounds of known mass defects for the lighter nuclei, and systematic principles for the heavier nuclei present. There should be energy (though not enough to explain the observations) to gain from such processes from K^{40}, Rb^{87}, Lu^{176}, Os^{187} and from one each of the pairs In^{113}, Cd^{113}, Sn^{115}, In^{115}, Te^{123}, Sb^{123}; none of these is present in substantial quantity. It is improbable that any natural nucleus possesses a more stable adjacent isobar not discovered in Nature.

(*b*) Induced emission of single nucleons: on grounds of known mass defect for the lighter nuclei and systematic principles for heavier ones; such processes, from naturally existing nuclei, always absorb energy.

(*c*) Induced α-emission: excluded for the lighter nuclei by known mass-defects. Not excluded for the heavier nuclei, since mass defects are not known with sufficient accuracy, and by the Geiger–Nuttall relation the life-times of low-energy α-emitters are too great for detection. However, with no heavier nuclei than silver present, energies greater than about 2 MeV. are excluded by this consideration, because they would lead to spontaneous decay at a detectable rate. Moreover, the Coulomb repulsion from a medium-heavy nucleus would assuredly give the α-particle sufficient energy to make a visible track.

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* See *Nature*, 160, 453 and 486 (1947).

(*d*) Induced fission: once again Coulomb repulsion would assuredly produce a visible track from the fission fragments, and it is inherently improbable that a meson could activate the process, say in silver, the only element which comes in question from the point of view of availability of energy.

(*e*) Processes with change of charge by 2, for example, of the type

$$At_Z^A + Y^- \rightarrow At_{Z-2}^A + Y^+,$$

where Y^- and Y^+ denote negative and positive mesons. It is to be expected that this process, if it can occur, would yield energy from about half the nuclei which possess stable isobars of charge diminished by 2. In the case of Zn^{64} going to Ni^{64}, measured mass defects indicate an energy yield of 9·8 ± 3 MeV. The conditions for this process are not satisfied by any nucleus present in substantial quantity in the photographic emulsion, namely, by isotopes of hydrogen, boron, carbon, nitrogen, oxygen, silver, bromine, iodine and sulphur; of these only S_{16}^{36}, the rarest (0·016 per cent) of the isotopes of sulphur, which is itself present only in traces, has a known stable isobar A_{18}^{36}. That is in the wrong direction, requiring the improbable converse process starting with a positive meson.

(*f*) Induced decay of naturally persisting nuclear isomers: this would imply the existence of isomers with life-times about 10^{12} times as great, and stored energies about ten times as great, as any yet known—a very improbable combination.

This seems to exhaust the possibilities among processes of nuclear degradation. On the other hand, it needs more consideration to exclude the possibility of processes of nuclear build-up, in which a proton is added to some other nucleus: such processes are almost all exothermic. The possibility of such processes arises from the special properties of the combination of proton and negative meson, which may be called a mesonic hydrogen atom, or an excited neutron, at choice.

A meson stopping in the emulsion loses kinetic energy from, say, 100,000 eV. down to 2,000 eV. in a fraction of a micron. This may occur either in silver bromide, or in gelatine, with comparable probability. In the latter case it is very likely to be in the neighbourhood of a proton, of which there are about twice as many as all other nuclei together in the gelatine. It should then, at first, enter a hydrogen-like orbit about the proton. The resulting compact neutral atom (radius, in the 'Coulombic ground-state', about 1/200 of the Bohr radius, thus 2·6 × 10^{-11} cm., and binding energy about 200 times that of a hydrogen atom, thus 2,700 eV.) should appear, from distances exceeding 10^{-10} cm., like a slow neutron. It should be able to pass freely through the electronic clouds of other atoms, and approach close to nuclei, without Coulomb repulsion. Indeed, the polarization of the mesonic atom in the field of a second nucleus should lead to an initial attraction.

The most probable next step would appear to be the capture of the meson by the nucleus of higher charge, and repulsion of the proton. There should, however, be a non-vanishing probability that the proton is captured, and the meson expelled. In one case at least, namely, that in which the second nucleus is a deuteron, the probability of the alternative reaction should be high. For by analogy with the hydrogen molecule-ion, H_2^-, the combination of deuteron, proton and meson should be stable in respect of Coulombic interactions with an internuclear separation of $10^{-8}/200 = 5 \times 10^{-11}$ cm. At this distance, with a very low Gamow barrier, the two nuclei should very readily unite, the meson acquiring kinetic energy by what may be described as 'internal conversion'. Thus, formally, we should have the reaction:

$$\begin{array}{llll} H_1^1(e^-) + Y^- & \rightarrow H_1^1(Y^-) + e^- & + & 2{,}700 \text{ eV.} \\ H_1^1(Y^-) + D_1^2 & \rightarrow H_1^1 D_1^2(Y^-) & + & 500 \text{ eV.} \\ H_1^1 D_1^2(Y^-) & \rightarrow He_2^3 + Y^- & + & 5{\cdot}46 \text{ MeV.} \end{array}$$

It is highly improbable that the small amount of deuterium present in the normal emulsion could account for the observed phenomena. The corresponding process with a second proton (forming a deuteron, since He^2 is not stable) requires the emission of a positron and neutrino which, between them, would take most of the 1·43 MeV. available, which is in any case insufficient. With heavier nuclei the details of interaction are more complicated, since, among other considerations, there will only be binding in the molecule-ion while it is in an excited state.

The mesonic hydrogen atom will be attracted to a second nucleus by virtue of polarization. Some energy can be dissipated to form the molecular combination, by Auger effect, which will cease to operate when the nuclei and meson are well within the K-shell of electrons. The combination dissociates when the meson falls by a radiative transition into a level in which it is concentrated around the nucleus of higher charge. The time taken for this radiation should be of the order $(hc/e^2)(\lambda/r)^2(1/\omega)$, which is about $10^6 Z^{-2}$ periods of the emitted radiation (as in hydrogen-like spectra) whether we are dealing with mesons or electrons. The characteristic frequency should be 200 times that of the corresponding electronic spectrum, that is, say, $10^{18} Z^2$, and the frequency of molecular vibration $(200)^{3/2}$ times that of electronically bound hydrogen compounds, that is, about 3×10^{17}. Hence, we estimate the life-time of the bound state as about $10^{-10} Z^{-4}$ sec., or about $3 \times 10^7 Z^{-4}$ periods of oscillation of the mesonic molecule-ion.

The Gamow barrier to be penetrated by the proton extends from the internuclear separation in the excited molecule-ion, r_1, to the distance at which the nuclei make contact, r_0. The meson still provides some screening within this distance, and we take the potential energy to be $E = (Z - 1)e^2/r$. We estimate r_1 as that distance at which the polarizing action of the second nucleus, on the mesonic hydrogen, regarded as linear with field strength, produces an equivalent displacement of the meson equal to its Bohr radius, $a_Y = 2{\cdot}6 \times 10^{-11}$ cm. Thus, $r_1 = 3a_Y\sqrt{Z/2} = 5{\cdot}5 \times 10^{-11} Z^{1/2}$ cm.: r_0 we take as $1{\cdot}45 \times 10^{-13}(A^{1/3} + 1)$ cm., where A is the mass number of the second nucleus. Then, if we write $\lambda^* = h/\sqrt{2M(E - E_0)}$ (where M is the mass of the proton) and neglect the initial kinetic energy E_0, the transparency of the barrier to a proton wave should be of the order

$$\exp\left\{-4\pi\int_{r_0}^{r_1}(1/\lambda^*)dr\right\}$$

$$=\exp\left\{\frac{-8\pi e\sqrt{2M(Z-1)}}{h}\left(r_1^{1/2}-r_0^{1/2}\right)\right\}$$

$$=\exp\left\{-3{\cdot}33\sqrt{Z-1}\left(7{\cdot}4Z^{1/4}-0{\cdot}4\sqrt{A^{1/3}+1}\right)\right\},$$

which is about 10^{-27} for B_5^{11}. This, subject to considerable error, for example, from the uncertainty of r_1, expresses the probability that the proton will penetrate the barrier in one attempt. Multiplying by the number of oscillations before dissociation, we find the probability of penetration before dissociation to be 10^{-21} in this case. This result may well be in error by several powers of 10, but it appears that if the model is at all relevant, the chance of penetration is insignificant for all nuclei beyond the deuteron. The same calculation for the latter, neglecting the inner screening and so writing 1 in place of $\sqrt{Z-1}$, gives a penetration probability of 10^{-9} per vibration, so that penetration may occur in about 10^{-8} sec.

Specific forces of the meson have been disregarded. There is an obvious chance that it will suffer nuclear capture or destruction before the two nuclei can interact, the probability of which is reduced by the fact that the meson is in excited states throughout the period significant for this process. If, on the other hand, the mesonic forces lead to some closer union of proton and meson than we have considered (differing from a neutron), it might well react with any nucleus.

The energy available from proton adhesion is small (1·96 and 0·51 MeV. respectively) for the 'saturated' nuclei C_6^{12} and O_8^{16}. For nearly all other nuclei it is 5 MeV. or more. The next most common nucleus in the gelatine is N_7^{14}, yielding 7·3 MeV., which would account for the observations if the product, O_8^{15}, was formed with an excitation of about 3·5 MeV. Boron was also present in these emulsions, and could yield more than enough energy by proton adhesion, but in this case the most likely reactions liberate α-particles.

This process can in any case be rejected statistically. For a total of 380 mesons observed to stop in the emulsion, four secondary mesons have been observed, with at least 500 μ of secondary track in the 50-μ thickness of the emulsion, and mutually consistent in energy yield. Geometrical probability indicates that about thirty times as many events should have occurred, in which the secondary meson passed out of the emulsion earlier: it could then either go undetected or be indistinguishable from a proton. On the other hand, one should not fail to detect a projected length of 50 μ of the end of a meson track. Hence the four observed secondary mesons are representative of about 120 ± 60 (the limits expressing probable error) whereas the 380 mesons observed to stop should represent not more than about 900 actually stopping. (For randomly directed straight tracks ending at random depths in an infinite layer of thickness H, the statistical proportion of all tracks which end in the layer which have horizontally projected ranges within the layer exceeding R is $(\sqrt{R^2/H^2+1}-R/H)$. For $R/H=1$, this is 0·414. For $R/H>1$, it is well approximated by $H/2R$, but for $R/H\gg 1$, track curvature will reduce the proportion below this estimate.)

Thus it appears probable that the production of a 4 MeV. secondary meson occurs for 13 ± 7 per cent of the mesons stopping in the emulsion. Presumably only about half the mesons are negative, and only about half of these can form mesonic hydrogen atoms (since H comprises 40 atomic per cent of the whole emulsion): if we suppose the interaction with a second proton is weak, so that the mesonic hydrogen is most likely, and about equally likely, to be attracted to carbon, nitrogen or oxygen (1 in 8 of which nuclei, in the gelatine, is N^{14}), we have an expectation of about 3 per cent if *every* encounter of a mesonic hydrogen atom with an N^{14} nucleus leads to capture of the proton, and on every occasion there is 'internal conversion' of the liberated energy, producing a secondary meson of 4 MeV. Unconsidered factors are mostly unfavourable, so that even on the small number of observations it is statistically improbable that they represent this process.

A further consideration is that the simple theory leads us to expect a larger number of easily observable 2 MeV.—and possibly of ½ MeV.—secondary mesons deriving their energy from proton adhesion to C_6^{12} and O_8^{16}: though it is a simple and plausible addition to the theory to suppose that these reactions are relatively 'forbidden'.

It should be added that such processes may be of importance in other circumstances; if it is correct to suppose that mesons can survive for, say, 10^{-8} sec. in hydrogen-like orbits about protons, then there is a finite chance that a meson can induce a nuclear build-up reaction, causing the attachment of a proton to a deuteron. However, with two or more cosmic ray mesons in the field, the whole of our observational knowledge about mesons requires re-examination.

I am indebted for a number of discussions to Dr. H. Fröhlich and Messrs. Lattes, Occhialini and Powell.

Note added in proof. Later observations enable the 'corrected observed' proportion of mesons producing secondaries to be refined from 13 ± 7 per cent to 12·8 ± 2·5 per cent (117 ± 20 in 917 ± 70), thus increasing the confidence with which the hypothetical alternative process can be rejected.

OBITUARIES

Prof. T. David Jones, C.B.E.

It is with much regret that we record the tragic death of Prof. Thomas David Jones in a motor accident which occurred outside Amesbury on August 30.

T. David Jones was born of a mining family at Aberyskir, Breconshire, in 1900. He was educated at the Technical College, Swansea, and the University College, Cardiff. After the First World War, during which he served with the 17th Lancers, he resumed his studies at the University of Birmingham. He graduated, and passed the Colliery Managers' Examination in 1922, obtained his M.Sc. in 1923 and the Ph.D. a year later. He was then appointed to the mining research staff directed by the late Prof. J. S. Haldane. In this capacity, he carried out extensive investigations into mining conditions, spontaneous combustion, geothermic gradients and mine lighting.

In 1936, Prof. Jones was appointed to the chair of mining at the University College, Cardiff, and in 1939 he became director of research to the Monmouthshire and South Wales Coal Owners' Association, in which position he was responsible for intensive investigations carried out on the suppression of dust in coal mines. He was invited in 1946 to visit and advise the colliery engineers of Belgium and Holland on various mining problems, and earlier this year had carried out an extensive tour at the request of the Commonwealth Governments of Australia and New Zealand. In April of this year he was appointed to the chair of mining at his old University at Birmingham.

Prof. Jones was a member of many learned societies and institutions, most of which he served on their councils; he was actively interested in all schemes connected with mining education and training, and for many years he had been actively connected with the Order of St. John. He was made a Commander of the British Empire in January 1947; a Commander of the Crown, Belgium, in June 1947, and a Commander of the Order of St. John of Jerusalem in July 1947.

He had high academic qualifications, a broad outlook on life, and an intense interest in his fellow beings. His boyish enthusiasm, together with his great energy, made him an outstanding personality, endeared him to his colleagues, and fired all who came in contact with him with his own enthusiasm.

J. HOWARD GRIFFITHS

WE regret to announce the following deaths:

Mr. John Dower, author of the report on National Parks in England and Wales (1945), prepared for the Ministry of Town and Country Planning, on October 3.

Dr. Stephen Miall, for many years editor of *Chemistry and Industry*, on October 12, aged seventy-five.

NEWS and VIEWS

Education in H.M. Forces

Now that the Royal Navy, the Army and the Royal Air Force are beginning to assume a peace-time footing, education in those Services is being revised. The Services are anxious to continue effective liaison with civilian education authorities in organising and developing educational facilities among serving men and women. An Army Education Advisory Board and a Royal Air Force Education Advisory Committee, both representative of a range of civilian educational interests, have already been formed. All this will affect the Central Advisory Council for Adult Education in H.M. Forces which, under the able secretaryship of Dr. Basil Yeaxlee, and with the help of its regional committees, has worked hard throughout the War and since (in an advisory capacity) in providing the necessary liaison between Service and civilian education authorities and in choosing and supplying lecturers and other educators (in an executive role).

The Council and the three Services have therefore agreed in principle to the following proposals, subject to further consideration of details: (1) The universities should be invited to consider their extra-mural departments taking over the work hitherto carried out by the regional committees of the Council. (2) Advisory functions of the Central Advisory Council should now be discharged by the inclusion of some of its members on the new Army Education Advisory Board and the Royal Air Force Education Advisory Committee. The Admiralty hopes to obtain advice from former members of the Council on an *ad hoc* basis. Meanwhile, until the end of 1948, the Council should continue to function as such.

So far as the Council's executive functions are concerned, it is suggested that these should in due course be assumed by an inter-Services Executive Committee whose members will represent the Services, the Ministry of Education and other civilian educational interests. If the new proposals are eventually put into effect, their success will depend upon the goodwill of the Services and civilian educationists and others concerned. If Service education is to be accepted as an integral part of national education, then it is up to both Service and civilian personnel to work together. In this respect, responsibility will devolve on the universities and other civilian education institutes and authorities to see that whatever facilities, advice and other assistance they can give to all three Services must be given whenever required; on the other hand, the Services must recognize that if their educational work is to attain a high grade and be recognized by the soldier, sailor and airman as a real and effective part of the nation's educational scheme, then the Service educational authorities must collaborate as much as possible with their civilian colleagues and counterparts.

British Dyestuffs: Mr. J. Baddiley

MR. J. BADDILEY, for many years research director of Imperial Chemical Industries, Ltd. (Dyestuffs Division), retired on September 30. He was intimately associated with research in the dyestuffs industry throughout the whole of the period popularly known as the renaissance of British dyestuffs. A pupil of Prof. Green at the University of Leeds, Baddiley was appointed as research chemist in the company of Levinstein, Ltd., at Blackley in 1909, and provided the first example of departure from Mr. Ivan Levinstein's policy of employing only German chemists. At an early date he exhibited a flair for inspiring and leading other research workers, and during his first years of service to industrial chemistry he guided an ever-increasing team of workers who were charged with the task of putting British dyestuffs on the map. During this period he discovered a range of dyes designed to produce level (or even) shades on viscose rayon. When I.C.I. was formed, he was made a delegate director responsible for research in the group of dyestuffs manufacturers in the parent company. Dyestuffs research was concentrated at Blackley and, during Baddiley's tenure of office, grew tremendously, embracing also the fields of rubber chemicals, auxiliary chemicals, organic polymers and synthetic drugs. Dyestuffs, his first love, remained his favourite, however, and perhaps his greatest single achievement was the discovery, in collaboration with the late Mr. A. Shepherdson, of a range of dyestuffs for the colouring of acetate rayon. Baddiley's high reputation in the dyestuffs and dyeing industries was recognized when he was awarded the Perkin Medal by the Society of Dyers and Colourists in 1939.

U.N.E.S.C.O. Field Scientific Officer for Far East

Mr. Jan Smid has been appointed field science co-operation officer for East Asia and the Philippines of the United Nations Educational, Scientific and Cultural Organisation. He will leave shortly for Nanking. He is a Czechoslovak civil engineer, thirty-five years of age, who studied at the Polytechnic at Prague, and then worked in Paris, during 1937 and 1938, at the École des Ponts et Chaussées. Joining the Czechoslovak Army in France in 1939, he was wounded. In 1942, he made his way to Britain, via North Africa, and rejoined the Czechoslovak Army, serving until 1946, when he returned to Paris to work in the office of Prof. Caquot, the well-known French civil engineer, for whom he had previously worked during the period 1937–39. The Field Science Co-operation Office at Nanking is the third which U.N.E.S.C.O. has set up—the other two being at Rio de Janeiro and Cairo; the creation of a fourth, in India, will be proposed at the next General Conference of U.N.E.S.C.O., which meets in Mexico City next month. The function of these centres of scientific co-operation is to make available, in areas where the need is especially felt, information and help on scientific matters otherwise obtainable only with great delay or difficulty.

British Council Science Officer for China

Dr. H. V. Walters, chief physicist at Messrs. Dufay-Chromex, Ltd., has been appointed British Council science officer for China. He will be working with Dr. R. A. Silo, director of the British Council's Science Office in China. Dr. Walters, who is thirty years old, obtained his B.Sc. degree in 1938 while at the Imperial College of Science and Technology, London, and with a grant from the Medical Research Council remained at the College for a further year working with Dr. W. D. Wright on colour vision. In 1941 he joined Messrs. Dufay-Chromex, Ltd., becoming chief physicist in 1944, when he was placed in charge of research work on colour and optics, and of filter developments and photographic testing. In the same year he obtained his Ph.D. for papers on the trichromatic theory of vision and the spectral sensitivity of the fovea and extra-fovea.

United Nations Organisation

The British Society for International Understanding (Benjamin Franklin House, 36 Craven Street, London, W.C.2) has published in its *British Survey* (7, No. 14. 6*d.*) a teacher's guide to the United Nations. This guide explains the organisation and membership of the body and reminds readers of its purposes as set forth in the original charter signed at San Francisco in April 1945. The vital Security Council, which embodies the final aim of the whole organisation, has not yet found an acceptable plan for the use of armed forces to prevent or resist a breach of the peace. The Great Power veto is the crucial problem that faces the United Nations. So far, Great Britain has not used the veto, but the Soviet Union has done so repeatedly. The pamphlet contains a clear account of the powers of the Security Council and some of the problems that confront it. Another section gives brief accounts of the fate of issues that have already been placed before the Security Council with greater or less success. Finally, there is some account of the work of the Trusteeship Council and the various economic and social agencies of the Council; here some progress has been made. The pamphlet deserves a wide circulation.

Supersonic Speed Flight Investigation

British experiments upon supersonic speed flight, using rocket-propelled aircraft, were commenced on October 8, when a Vickers radio-controlled plane was flown at St. Eval, Cornwall. It was launched from a 'Mosquito' at about 35,000 ft. altitude, flew for 90 sec. and dived into the sea, according to plan. Information upon its behaviour was obtained by a technical observer watching from the launching 'Mosquito', photographs taken by a 'Meteor' jet-propelled aircraft, and radio signals upon speed, accelerations, pressures, etc., sent out automatically from transmitting apparatus on the experimental aircraft itself. It was hoped that a speed of more than 800 miles an hour would be attained, the speed of sound at that height being approximately 760 miles an hour. The results, mostly mechanically recorded for accuracy and to allow of working them out at leisure, will take about a week to analyse, but it is thought that the desired speed was reached.

The experiment was not entirely successful as the machine lost height more rapidly than was anticipated, probably due to what appeared to the observer to be instability in control. It was hoped that it would have climbed after its rocket engine commenced to function. Nevertheless, it will supply much valuable information, and has proved that this technique for such investigations is possible. Improvements in the design of further experimental aircraft, as a result of the analysis of these experiments, should make it possible to continue with radio-controlled aircraft without risk to human life.

Plant and Soil

An international periodical entitled *Plant and Soil* is to be issued towards the end of this year. It is to be devoted to the study of plant nutrition, plant chemistry and the related subjects of soil science, soil microbiology and soil-borne plant diseases. To meet the increasing demand for intensive crop production all over the world, quick exchange of the results of scientific research between the workers in this field is necessary; a number of outstanding scientific workers from different countries have therefore decided to collaborate in establishing the new journal. The editorial board includes the names of Gäumann (Zurich), Lundegårdh, Penningby and Melin (Uppsala), Hoagland (Berkeley), Koningsberger (Utrecht), Waksman (New Brunswick), Westerdijk (Baarn), and Virtanen (Helsinki). The journal will be published by the Martinus Nijhoff Publishing Company, The Hague. The subscription price is 7.50 dollars a year for one volume containing about 400 pages (four parts). Original contributions in English, French or German should be sent to the secretary of the Board of Editors, Dr. E. G. Mulder, Agricultural Experiment Station, Eemskanaal ZZ. 1, Groningen, Holland.

R.C.A. Technical Papers

The *R.C.A. Review* (Radio Corporation of America, R.C.A. Laboratories Division, Princeton, New Jersey) has recently issued volume 1 and volume 2 *a* of the Index to R.C.A. Technical Papers. Volume 1 covers the years 1919–45, and 2 *a*, 1946. It is planned to publish the yearly indexes, of which 2 *a* is the first, as sub-volumes, consolidating them under one cover at the end of five years as "R.C.A. Technical Papers" (1946–1950)—Index—Volume 2". Volume 1 supersedes "Index—Technical Papers by R.C.A. Engineers (1919–1939)" published by R.C.A. Institutes Technical Press in 1940. The Indexes contain substantially all the technical papers and books, published in English, on subjects in the radio, electronics and related fields, the authors or co-authors of which were associated with the Radio Corporation of America or its subsidiaries. Both indexes are similar in form. Bound in stout paper covers, they contain an explanatory list of abbreviations of titles of periodicals used in the Indexes, a chronological index, followed by a section in which the papers are arranged alphabetically according to title, an author index and a subject index. About 1,800 papers are listed in volume 1 and 200 in volume 2 *a*.

The Prehistoric Society

It would be difficult to find anywhere a publication on matters prehistoric more important than the *Proceedings of the Prehistoric Society*. Even during the War the editor, though in the R.A.F., managed from time to time to issue a volume. Now that the War has ended a really excellent number (New Series, vol. 12) has been published. The list of contents alone indicates the scope of the Society's interests: the relationship of bog stratigraphy to climatic change and archæology, by Dr. H. Godwin; seal hunting in the Stone Age of north-west Europe, by Dr. J. G. D. Clark; prehistoric investigations in British Somaliland, by M. C. Burkitt and P. E. Glover; the Levalloisian industries of Egypt, by Miss Caton Thompson; the late Bronze Age razors of the British Isles, by Prof. C. M. Piggott; prehistory in Ireland, 1937–46, by S. P. O'Riordain. There are also a number of notes, reviews and a list of members. There are many illustrations (one in colour), maps and diagrams. It is indeed pleasant to find that at least one learned society has managed to return to what is really a peace-time standard of publication.

New Seismological Observatories

The seismograph station at Honolulu has been transferred from the University of Hawaii to the new site of the Honolulu Magnetic and Seismological Observatory of the U.S. Coast and Geodetic Survey near Barbers Point, south-west Oahu. The new co-ordinates are tentatively reported as 21° 18·27′ N., 158° 05·76′ W. Recording began on October 17, 1946. One component of a Wood–Anderson seismograph was put in operation at Manzanita Lake in Lassen Volcanic Park, California, through the co-operation of the University of California and the U.S. Coast and Geodetic Survey.

American Physical Society Symposia

The May meeting of the American Physical Society, held in Washington, included a joint session with the American Meteorological Society; a two-session programme on "Low Temperature Physics", held under the sponsorship of the United States Navy; a two-session symposium on the "Physics of Surface Phenomena"; and a symposium on "Shock-wave Phenomena", presented by the Committee on Fluid Dynamics. As part of the general programme, two invited papers, one by Dr. Kathleen Lonsdale on "The Diffuse Scattering of X-Rays", and the other by Prof. S. A. Goudsmit, on "Why Germany did not get the Atomic Bomb", were given. Of the other invited papers, those dealing with the theoretical and statistical aspects of low temperatures were by J. C. Slater, Felix Bloch, and V. Johnson and K. Lark-Horovitz; and on the experimental side, by J. G. Daunt and H. Grayson, who discussed the properties of liquid helium II and superconductivity respectively. The full programme of the meeting and the abstracts of the 165 contributed papers appear in the July 15 issue of the *Physical Review* (**72**, 151–157).

Announcements

The Lord President of the Council has appointed Prof. P. I. Dee, professor of natural philosophy in the University of Glasgow, and Sir William Griffiths, chairman and managing director of the Mond Nickel Co., Ltd., to be members of the Advisory Council for Scientific and Industrial Research. Sir Lawrence Bragg, Sir John Lennard-Jones, Sir Andrew McCance and Sir Raymond Streat have retired from the Advisory Council on completion of their terms of office.

Dr. Norman C. Wright, director of the Hannah Dairy Research Institute, Scotland, has been appointed chief scientific adviser to the Minister of Food.

Mr. A. T. Green, director of research of the British Refractories Research Association and the British Pottery Research Association, has been appointed honorary general secretary of the British Ceramic Society in succession to the late Dr. J. W. Mellor.

Lord Rayleigh will open the new Physics Laboratories of the British Iron and Steel Research Association at Battersea Park Road, London, on October 22.

The fourth Dalton Lecture of the Royal Institute of Chemistry (Manchester and District Section) will be given by Dr. D. T. A. Townend, director of research, British Coal Utilisation Research Association, who will speak on "Fuel and Chemistry". The lecture will be delivered at the Albert Hall, Manchester, on November 27 at 7 p.m.; it is open to the public.

Research scholarships will shortly be awarded by the Royal College of Surgeons of England. There are two vacant Leverhulme Research Scholarships of the annual value of £400, with an allowance not exceeding £100 for expenses of research, tenable for one year but renewable. The awards, which will be made either as scholarships or as grants-in-aid, are for the investigation of biological or clinical problems of disease as it occurs in man, with a view to the extension of surgical knowledge. Facilities for research will be available in the Bernhard Baron laboratories of the Royal College of Surgeons in Lincoln's Inn Fields or at the Buckston Browne Farm, Downe, Kent. Applications must reach the Secretary, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2, before October 27.

The Society for Visiting Scientists (5 Old Burlington Street, London, W.1) is arranging a discussion meeting on "Law-making in Science" to be held on October 29 at 7.30 p.m. The chairman will be Mr. G. S. W. Marlow, and the speakers Sir Wavell Wakefield, M.P., Mr. A. R. Blackburn, M.P., and Dr. Cecil Gordon.

Erratum. Prof. J. S. Turner and V. Hanley, referring to the communication "Malonate and Plant Respiration" (*Nature*, Aug. 30, p. 296), write: "We were unable, owing to delay of mail, to correct the following mistake in the above letter. The correct figures are more in keeping with the interpretation put forward. Figures for undissociated malonic acid should read: *p*H 4·0, 6·5 per cent; *p*H 5, 0·6 per cent; *p*H 6, 0·02 per cent; *p*H 7, nil."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

'Radiation Damping Theory' and the Propagation of Light

HEITLER and collaborators[1] have proposed a modification of radiation theory in order to remove the well-known divergencies. A variation of this procedure has been proposed by several authors[2]. We shall refer to these two forms as the time-dependent and the stationary form of the theory respectively.

In the time-dependent theory one starts from a modified version of the equations of field theory, in which a distinction is made between states in which energy is conserved and others, so-called intermediate states. The former are defined as those in which the unperturbed energy (omitting coupling terms) differs from that of the initial state, 0, by less than an amount, Δ, of the order of the line-width. It is assumed that the intermediate states differ from this energy by amounts large compared to the line-width and hence large compared to Δ.

In these circumstances, states of equal energy can either be reached from the initial state by a direct transition (states A, B) or by way of one or more intermediate states (states c, d . . .). The possibility of an indirect coupling by way of another state of equal energy is unimportant. The equations of radiation theory can then be written in the form of Heitler's equation (I′) which, in the conditions envisaged, is still practically identical with the usual equations. The essence of the damping theory is then to omit from (I′), of all terms linking any two given states A and B, those which contain more than the least possible number of steps ('roundabout transitions'). This leads to an equation (II) in which the amplitude of each state still appears as a function of time.

Alternatively, in the stationary theory, equations are used which define only the amplitudes of states of equal energy, and the results do not claim to be valid except in the limit of very long times.

Recently, Bethe and Oppenheimer[3] have shown that the omission of the roundabout transitions leads to trouble in the case of the scattering of charged particles by a centre of force. Their arguments have been criticized on the grounds that they neglect terms of higher order than the first in $e^2/\hbar c$, which amounts to neglecting the possibility of more than one photon being emitted. Actually, one knows that in infinite space the number of photons will show a logarithmic infinity (infra-red catastrophe).

We may, however, consider the scattering inside a finite box with conducting walls. In that case the probability of emission of two or more photons is negligible, provided (log $E/h\nu_{\text{min.}}$)/137 is a small number. Here E is the initial energy of the particle and $\nu_{\text{min.}}$ the frequency of the longest wave possible in the box. This limits the size of the box, but it need not be much smaller than the universe.

In that case the approximation used by Bethe and Oppenheimer is justified and, for a box of reasonable size, it gives then the result that the total collision cross-section contains a logarithmic term depending on $\nu_{\text{min.}}$, and hence on the size of the box. The variation of the cross-section due to that term may be of the order of one part in 10^6, and its observation, together with the knowledge that the particle is within the box, would, therefore, not violate the uncertainty relations.

Now the scattering can, in fact, be observed with sufficient accuracy in a time less than that needed for a light signal to reach the wall of the box, and, on physical grounds, it ought not to be influenced at all by the existence of the walls. One would, therefore, suspect that the radiation damping theory is not compatible with the description of the propagation of light with light velocity. In order to investigate this, we have studied directly the transmission of light from one atom to another in the damping theory.

Assume two identical atoms, P and Q, each of which has only two states, 1 and 2, differing in energy by $h\nu_0$. They are at a distance r from each other, such that $c/\nu_0 \ll r \ll c/\gamma$, where γ is the line width of the excited state, 2. These two inequalities are evidently well compatible. Initially P is excited (state 2) and Q in state 1, and no light quanta (at any rate of frequencies comparable to ν_0) are present. The lower limit of r ensures that the knowledge of the energy of the atoms specified by this description can be obtained in a time much less than r/c. We must then expect from a reasonable theory that the probability of Q being excited should remain zero for a time of about r/c and should then rise.

If, however, we apply the time-dependent damping theory, we have to consider as states of equal energy the initial state 0, the state A, in which Q instead of P is excited, and the state B, in which both atoms are in the ground state and there is a photon of frequency about ν_0. 'Intermediate states' are those in which there is a photon of frequency appreciably different from ν_0 and, since these states form a continuum, the assumptions made in deriving equation (I′) do not hold. We must choose our interval Δ of the order of the line-width, say, equal to $k\gamma$, where k is a number of order unity or less. In this case A and 0 are not coupled directly, but they are coupled through a state of equal energy as well as through 'intermediate states'. The procedure of damping theory is therefore ambiguous.

We may either regard the terms involving intermediate states as 'roundabout transitions' and omit them, or we may include them. If they are omitted, the time-dependent amplitude for state B will contain only Fourier components the frequency of which is the same within a range $k\gamma$, and since the number k must be independent of the problem to which the theory is applied, we can always make $k\gamma$ less than c/r. It is then impossible to obtain a function which remains zero for a duration r/c unless it is always zero. Indeed, calculation shows that the amplitude of state B is a power series in the time which begins with a quadratic term. Alternatively, if we had included intermediate states, equations (I′) and (II) would contain a direct coupling between states 0 and B and we would also find a finite probability of immediate excitation of atom Q.

In either case, the present form of the time-dependent radiation theory does not give a sensible answer to the propagation problem, and it cannot, therefore, be regarded as a satisfactory *general* procedure in radiation theory.

In the stationary theory, on the other hand, the problem of light propagation cannot be treated, since only asymptotic results are obtained from this theory. It may be, of course, that the procedure can be generalized so as to include non-stationary phenomena. If this is possible, without affecting the stationary case, we must find, after an infinite time, a cross-section depending on the size of the box. If the theory is to account for the propagation of light it must, however, after a finite time T, be independent of the linear dimensions of the box provided only they are greater than cT. It follows, then, that a correct generalization of the damping theory to time-dependent problems, which must differ from Heitler's equation (II), would have to lead to the result that the cross-section would depend on the time taken for the observation. We can see no rigorous argument against such a result, but it seems curious.

We are indebted to Dr. Hu for directing our attention to the difference between the two forms of the damping theory.

B. FERRETTI
R. E. PEIERLS

University,
Birmingham 15.
Aug. 14.

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[1] Heitler, W., "The Quantum Theory of Radiation" (Oxford, 1944, 2nd ed., 240–246).

[2] Pauli, W., "Meson Theory of Nuclear Forces" (New York, 1946), chapter 4.

[3] Bethe, H. A., and Oppenheimer, J. R., *Phys. Rev.*, **70**, 451 (1946).

Radiation Pressure

THE methods given in most text-books for finding an expression for the pressure exerted by electromagnetic radiation on an obstacle generally depend upon a consideration of the lateral pressure of tubes of force, or some similar argument, and do not answer *directly* the question: What is the action of the electromagnetic field on the electrons in the absorbing (or reflecting) surface on which the pressure is actually observed? The following short method of finding the action of the field on an electron, and hence on a body, is therefore given here.

Suppose a train of plane electromagnetic waves is proceeding in the x-direction; let the electric and magnetic fields at a point A be in the y-direction and the z-direction respectively, and have components $(0,E_y,0)$ (in E.S.U.) and $(0,0,H_z)$ (in E.M.U.) respectively at a given moment. An electric charge at A will be set in motion in the y-direction by the action of the electric field, and will therefore experience a force in the x-direction owing to the action of the magnetic field. If the velocity components of the motion are $(0,v,0)$, then the force in the x-direction will be

$$P_x = H_z ev/c,$$

where c is the velocity of light in free space. If the charge is quite free to move and radiates no energy, the velocity v will lag behind the sinusoidally varying field E_y by a quarter of a cycle. It will also lag behind the magnetic field by a quarter of a cycle, and thus the mean value of $H_z v$, and therefore of P_x, will be zero.

If the charge does not move freely, then it will take energy from the electromagnetic field. The field does work on the charge at a rate

$$\frac{dW}{dt} = E_y ev,$$

and the charge, therefore, takes energy from the field at this rate. But since $H_z = E_y$ for a progressive wave in free space, it follows that

$$P_x = \frac{H_z ev}{c} = \frac{E_y ev}{c} = \frac{1}{c}\cdot\frac{dW}{dt}.$$

This shows that when an electric charge absorbs energy at a rate dW/dt from a train of electromagnetic waves, it experiences a force, $\frac{1}{c}\cdot\frac{dW}{dt}$, in the direction of the wave-motion. An equivalent statement is: when an electric charge receives an amount of energy W from a train of electromagnetic waves, it receives also momentum W/c in the direction of the wave-motion.

Thus if radiation with energy density ε per unit volume falls on a surface which absorbs it completely, the total rate of absorption of energy by the electrons in the absorber must be $c\varepsilon$ per unit area of absorber, and the absorber must therefore experience a pressure $\frac{1}{c}\cdot c\varepsilon = \varepsilon$. In the case in which all or part of the radiation is reflected, we can apply similar arguments to show that the reflected radiation exerts an additional pressure on the reflector.

ALEXANDER R. STOKES

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Paramagnetic Resonance and Magnetic Energy Levels in Chrome Alum

Zavoisky[1] and also Cummerow and Halliday[2] have shown that a resonance absorption of high-frequency waves occurs in some paramagnetic salts in a magnetic field of appropriate value. This is due to induced transitions between two of the energy levels of the paramagnetic ion, the energy of which depends on the magnetic field. In the simplest case where the magnetic moment is due to spin only, the difference of energy is given by $2\mu_0 H$, where μ_0 is the Bohr magneton and H the magnetic field. The resonance condition is then $2\mu_0 H = h\nu$. The results obtained so far have shown a single resonance absorption with a peak very near the value given by the above relation.

We have investigated the absorption in a single crystal of chrome alum at wave-lengths between 3 and 10 cm. In this case, several absorption peaks appear, and typical curves of absorption against magnetic field at a fixed wave-length are shown in Fig. 1. The curves 1, 2 and 3 were obtained at a wave-length of 3·18 cm. and with the magnetic field directed along the normals to the 100, 110 and 111 planes of the crystal respectively. The crystal was placed in an H_1 resonator arranged so that the oscillating magnetic field was at right-angles to the steady field. The ordinates in Fig. 1 are proportional to the absorption in the salt (the scale is different for the three curves) and are obtained by measuring the decrease in Q (circuit magnification) of the resonator at different values of the magnetic field.

A theoretical treatment of the lowest energy-levels of the Cr^{+++} ion in chrome alum under the combined influence of the crystalline electric field and of an external magnetic field has been given by Broer[3]. In this treatment it is assumed that the crystalline electric field is mainly of cubic symmetry, but that there is also a small component with trigonal symmetry, the trigonal axis being one of the space diagonals of the unit cell. The lowest energy-levels are

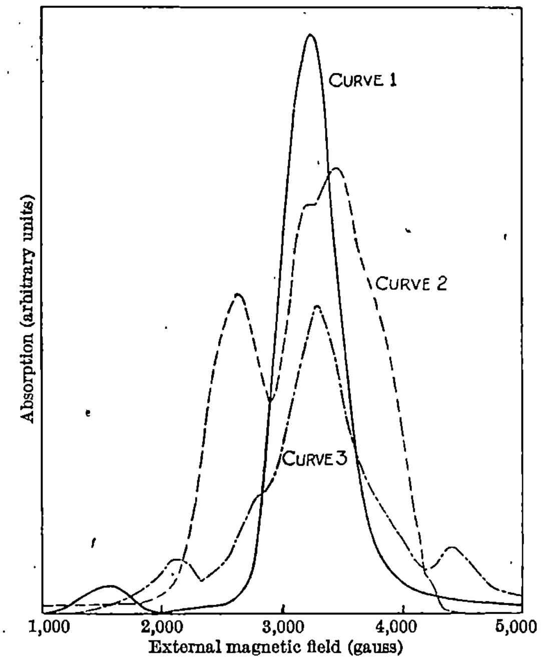

Fig. 1

then found to be two degenerate levels of spin ± 1/2 and ± 3/2 separated by a small interval of energy a.

Fig. 2 shows how the energy of the four levels varies with magnetic field. Two cases are shown for different directions of the magnetic field corresponding to cos $\theta = 1$ (full lines) and cos $\theta = 1/3$ (broken lines), where θ is the angle between the trigonal axis and the magnetic field. The ordinates in Fig. 2 are expressed in terms of the energy interval a. Experimentally the frequency is kept constant and the magnetic field varied, and it will be seen that there are several values of the magnetic field at which transitions of given energy should be found, and that these will depend on the orientation of the crystal in the magnetic field.

As an example, the case where the magnetic field is directed along a space diagonal of the unit cell may be considered. Here cos $\theta = 1$ for one out of four Cr ions and cos $\theta = 1/3$ for the others. The experimental results obtained at $\lambda = 3 \cdot 18$ cm. are shown as curve 3 in Fig. 1, and similar curves were obtained at other wave-lengths up to 10 cm. From these curves may be plotted the values of H at which peaks of absorption occur, against $1/\lambda$, and these are shown as the experimental points in Fig. 3. Also plotted in Fig. 3 are the theoretical curves of H against $1/\lambda$ for various transitions which can occur. The full lines are for cos $\theta = 1$ and the broken lines for cos $\theta = 1/3$. Only the three well-defined peaks in curve 3 have been plotted in Fig. 3. Other absorption lines should occur on each side of the main peak, and there are clear indications of these in the experimental curves. Again, in curve 1 of Fig. 1 the main transitions should give two lines close together, but these are not resolved and appear as a single large peak of absorption. Thus there is general agreement between the experimental results and the theoretical description; but owing to the considerable width of the absorption lines it is difficult to verify the theory in great detail.

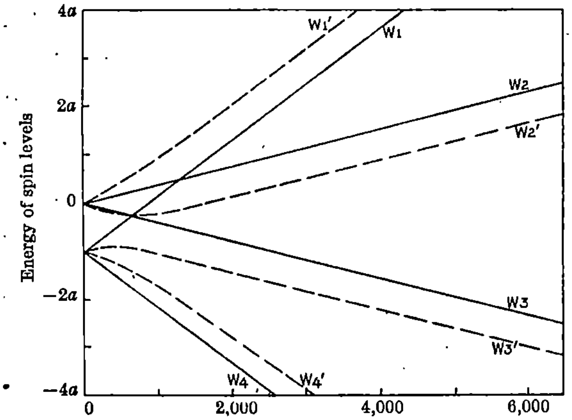

Fig. 2

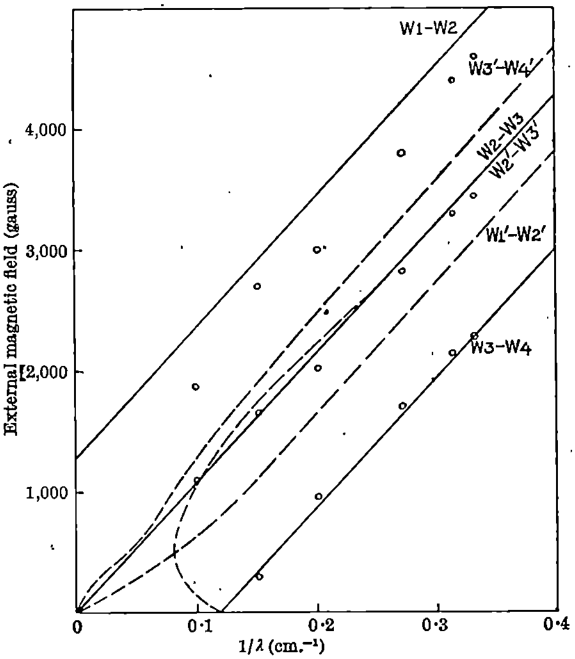

Fig. 3

From these measurements it appears that the best value of a, the 'splitting' of the energy-levels at zero magnetic field, is $0 \cdot 12$ cm.$^{-1}$, and this value has been used in the theoretical calculations. This compares with the value of $0 \cdot 17$ cm.$^{-1}$ found from low-temperature measurements. The difference may be due to a change in the crystalline electric field with temperature.

Thus it appears that, in suitable cases, this method of investigation may be capable of giving detailed information of the lowest energy-levels of a paramagnetic ion in a salt, and therefore of the crystalline electric field acting on that ion.

A full account of these measurements and also of measurements on other salts will be published in due course.

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July 14.

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[1] Zavoisky, E., *J. Phys. U.S.S.R.*, 10, 197 (1946).

[2] Cummerow, R. L., and Halliday, D., *Phys. Rev.*, 70, 433 (1946).

[3] Broer, L. J. F., *Physica*, 9, 547 (1942).

Photo-Disintegration of the Deuteron

THE theory of the photo-disintegration of the deuteron[1] indicates that the process should be predominantly due to photo-electric transitions for γ-ray energies considerably greater than the threshold energy (2·18 MeV.). The angular distribution of the protons emitted in such transitions should be represented by the function

$$f(\theta)d\theta = k\sin^2\theta d\theta,$$

where θ is the angle between the direction of the emitted proton and that of the incident γ-ray, and $f(\theta)$ is the number of protons emitted per unit solid angle at the angle θ.

At high γ-ray energies, according to more recent calculations based on meson theories of nuclear interaction[2], the angular distribution of the emitted protons should show deviations from this distribution, particularly in an increase of the ratio of the number of protons emitted at small angles to the number emitted in directions perpendicular to that of the γ-ray beam. Accurate determinations of the angular distribution at high energies should therefore yield information concerning the validity of various theories of the short-range forces between the neutron and the proton.

It is the purpose of this note to describe some preliminary results obtained in the course of an investigation of the photo-disintegration process by the photographic plate method. A proton beam of 80 microamp., accelerated through 950 kV. by the Cavendish Laboratory high tension equipment, was used to bombard a thick target of sodium fluoride. The 6 MeV. γ-rays produced in the bombardment of fluorine by protons[3] were incident upon a series of photographic plates, the emulsions of which contained a proportion of deuterium. The plates were of the Ilford Nuclear Research *C*2 type, with 100 micron coating, and they were specially prepared with a loading of calcium nitrate containing heavy water of crystallization. The proportion of heavy water in the emulsion was approximately 6 per cent by weight. The plates were exposed for five hours at a distance of 5 cm. from the fluoride target, and they were processed in the usual manner. A microscope examination showed that proton tracks occurred in the plates and that the γ-ray fogging was not excessive.

The exposed plates were examined under a high-power microscope, and an area of 230 sq. mm. was covered in this investigation. The observers recorded all proton tracks with a range greater than 20 microns which were entirely contained in the emulsions. The direction of each proton recorded was ascertained by observation of the variation of the grain density along the track. Fig. 1 shows the distribution in range of 29 tracks occurring in the angular range $70^\circ \leqslant \theta \leqslant 110^\circ$. The tracks represented in this diagram had an angle of dip of less than 10° in the emulsion; this criterion was adopted because the accuracy of range measurements decreases with increasing angle of dip. Fig. 1 shows that a proton group occurs with a mean range of 36 microns, corresponding to a proton energy of 1·88 MeV. This is clearly due to the photo-disintegration process, since the calculated γ-ray energy is $(6 \cdot 0 \pm 0 \cdot 2)$ MeV., in agreement with the known energy of γ-rays emitted in the F + *p* reaction. At angles greater than 110°, proton tracks were less abundant, but the photo-disintegration group was still resolved, and the mean range decreased with increasing angle in the correct relation. At angles less than 70°, a larger number of proton tracks was found, and the correlation of range with angle showed clearly that some of these were caused by protons scattered by a background of neutrons which arose from the contamination of the accelerating tube with deuterium. These neutrons were probably responsible also for the small number of proton tracks occurring outside the main group in Fig. 1. At angles less than 70°, the protons produced by photo-disintegration were not clearly resolved from those scattered by neutrons.

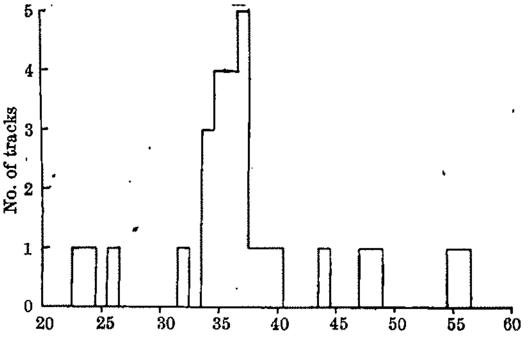

Fig. 1. RANGE DISTRIBUTION OF PROTON TRACKS IN ANGULAR RANGE $70^\circ \leqslant \theta \leqslant 110^\circ$

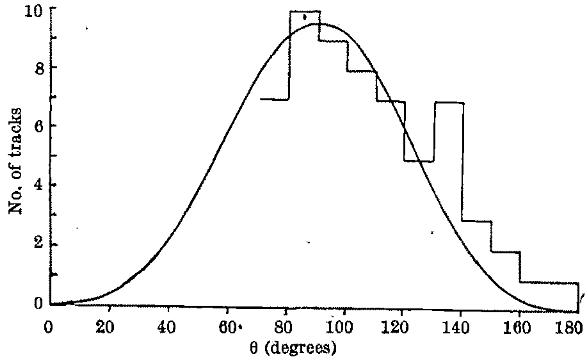

Fig. 2. ANGULAR DISTRIBUTION OF PROTON TRACKS PRODUCED IN PHOTO-DISINTEGRATION OF DEUTERIUM

The total number of proton tracks recorded was 213, and, of these, 60 occurring in the angular range $70^\circ \leqslant \theta \leqslant 180^\circ$ were ascribed to the photo-disintegration process. This abundance is in approximate agreement with that calculated from the known γ-ray strength of the source and the cross-section determined by Van Allen and Smith[4]. The angular distribution of the photo-disintegration protons is shown in histogram form in Fig. 2. The continuous curve is the theoretical curve, calculated from the $f(\theta)$ distribution with a small correction for escape of protons from the emulsion and adjusted to fit the experimental results at $\theta = 90^\circ$. The agreement between theoretical and experimental distributions is fairly close and the discrepancies at very high angles are probably due to the lack of accurate geometrical conditions in the irradiation of the plates.

This method of investigating the photo-disintegration of the deuteron and of measuring γ-ray energies is capable of several improvements, particularly in the introduction of a higher proportion of deuterium into the emulsions, and of extension to higher γ-ray energies. We are indebted to Mr. C. Waller and the research staff of Ilford, Ltd., for their work in preparing the plates, and to Dr. W. E. Burcham for much helpful advice.

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Mechanism of Ferromagnetic Dispersion

Further experiments have been made to elucidate the mechanism responsible for the magnetic dispersion and absorption of γ-ferric oxide at centimetre wave-lengths, previously reported[1]. Using the wave-guide impedance method[2,3], the high-frequency permeability $\mu = \mu_R - i\mu_I$ of γ-Fe_2O_3-wax mixtures has been measured in a coaxial transmission line, when a static magnetic field H is applied perpendicular to the axis. Typical results obtained on specimens containing 32·6 per cent by volume of γ-Fe_2O_3 are plotted in Fig. 1, together with measurements of the incremental static permeability, μ_0.

Various theories of ferromagnetic dispersion have been proposed. Skin effect, suggested by Page[4] and Kittel[5] as the dispersion mechanism for powders and metals respectively, is negligible in γ-Fe_2O_3 at centimetre wave-lengths[3]. Becker[6] has developed a theory of dispersion, due to eddy-current fields produced by oscillatory displacements of the domain-walls. Irreversible displacements, corresponding to the peak in the $\mu_0 - H$ curve, should disappear at low frequencies, and the present results substantiate this.

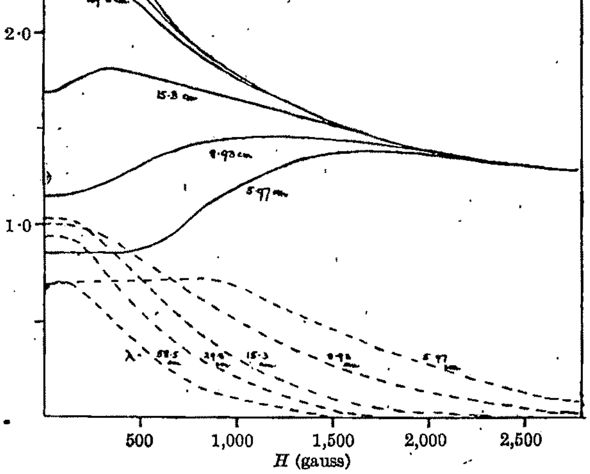

Fig. 1

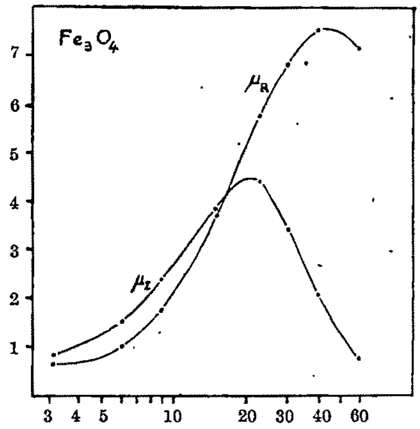

Fig. 2

It does not appear, however, that the micro-wave dispersion is attributable to Becker's other mechanism, the relaxation of reversible displacements. The insensitivity of μ to applied fields of a few hundred gauss indicates the action of a strong- and not a weak-field effect, while the experimental $\mu - \lambda$ curves have the characteristics of a damped resonance and not a relaxation.

It appears rather that the primary mechanism in the high-frequency magnetization is domain-spin rotation. For large H, μ is real and equal to μ_0, but as either λ or H is decreased, μ_R falls below μ_0 while μ_I increases, indicating a phase lag of the spin-rotation behind the high-frequency field. Landau and Lifshitz[7] have developed a theory of dispersion due to spin-rotation, and they predict a resonance occurring when the applied frequency is equal to the spin precession frequency in the internal crystalline field. Allowing for their neglect of eddy-current damping, the observed dispersion is in good agreement with this theory. The peak which might be expected in the $\mu_R - \lambda$ curve lies outside the measured wave-length range for γ-Fe_2O_3, but such a peak has been observed in measurements on Fe_3O_4, plotted in Fig. 2.

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Location of the Currents Causing the Solar and Lunar Diurnal Magnetic Variations

In 1882 Balfour Stewart[1] put forward the view that the solar and lunar diurnal magnetic variations were produced by currents in the upper atmosphere. He suggested that these currents were produced by the 'dynamo' action of thermal or tidal motions of conducting air across the earth's main magnetic field. Schuster[2] put these suggestions on a quantitative basis. It was later realized (Chapman[3]) that there were difficulties in assigning both the solar and lunar variations to a single ionized region. For example, the amplitude of the former is some 2·4 times larger in summer than winter, whereas the corresponding ratio for the latter is 4. Again, solar variations are some 1·6 times greater at sunspot maximum than at sunspot minimum, but lunar variations show little difference in amplitude between sunspot maximum and minimum. Since it is unlikely that the tidal motions change so markedly with season and sunspot activity, it seems probable that the conductivities of the regions responsible for the variations change in the above ratios: and since these ratios are different for solar and lunar variations it would seem that these variations must arise in different conducting regions of the atmosphere.

Appleton's discovery of the existence of more than one ionized region in the upper atmosphere appeared likely at first to lead to an early solution of this difficulty. In particular, the identification by Fleming[4] and McNish[5] of temporary augmentation of solar variation with temporary increase in D-region ionization suggests strongly that a main part of the solar variation is produced in and near this region. This leaves the lunar variation to be assigned to one of the other regions of the ionosphere. Unfortunately, none of these other regions exhibits seasonal and sunspot changes in conductivity which agree even roughly with those shown by the lunar variations. In general, all the known regions show too great a sunspot variation and too little seasonal variation for such identification. It is unlikely, from consideration of the conductivities at various pressures (in the presence of the earth's permanent magnetic field), that the lunar variations could be produced below the D-region, or above the F_2-region. Hence we are faced with the dilemma that the lunar variations cannot apparently be produced in any of the known, or even in any of the possible unknown, ionized regions of the upper atmosphere.

A way out of this difficulty appears to emerge from the results of a statistical study of tidal movements in the ionosphere, which has been proceeding for the past two years. One object of this analysis has been to test the concept that tidal height changes in ionospheric levels, such as were discovered by Appleton and Weekes[6], are not due directly to atmospheric tidal pressure changes, but are a by-product of the resulting 'dynamo' currents. Thus, at the pressures existing in the ionosphere, ions and electrons must drift vertically whenever a horizontal electric force acts across the horizontal component of the earth's field. The pattern of ionosphere currents which is necessary to explain the magnetic variations is well known. It consists of large roughly circular whorls in each hemisphere, with foci near lat. 40°. A crucial test of the above concept is then to determine the phases of the tidal movements of a given region of the ionosphere at latitudes on the poleward and on the equatorial sides respectively of these foci. If the concept be correct, there should be a reversal of phase on crossing the foci; while on the simple tidal hypothesis the phase should be approximately constant at all latitudes. Appleton and Weekes found that the E-region in south-east England reached its maximum height 11·2 hr. after lunar transit. A corresponding study of four years hourly data at Canberra (lat. 35·3° S.) shows that the E-region at this latitude attains maximum height 5·1 hr. after lunar transit. Almost identical results have been obtained for other Australian stations at lower latitudes. It seems, therefore, that the E-region height variations at low latitudes (less than 40°) are almost exactly out of phase with those in England, and we should be on safe ground in interpreting the sense of height movements in the ionosphere in terms of the directions of the electric currents there.

On this basis the results of the statistical analysis of the lunar height variations in the E-, F_1- and F_2-regions at a number of ionospheric observatories have been examined. It has been found that the currents in each of these regions are almost exactly out of phase with those required to produce the lunar variations. It follows from what has been said above that the main seat of the lunar variations, like that of the solar variations, probably lies in the D-region.

At first sight this surprising conclusion only seems to increase the initial difficulty of explaining the different seasonal and sunspot variations of the solar and lunar variations. Further study of the *solar* tidal movements in the E-, F_1- and F_2-regions of the ionosphere has brought to light a circumstance, however, which appears to provide a logical explanation of their different behaviour. This statistical study of the solar ionospheric tidal movements shows that the solar currents in the E-, F_1- and F_2-regions are substantially in phase with those which must be presumed to flow in the D-region, on McNish's evidence. On the basis of these analyses we may represent the solar variations (S) and the lunar variations (L) thus:

$$S = S_D + S_{EF} \quad . \quad . \quad . \quad . \quad (1)$$

$$L = L_D - L_{EF} \quad . \quad . \quad . \quad . \quad (2)$$

If now L_{EF} is not much smaller than L_D (say, 12 per cent less) the observed peculiarities of the lunar variation fit into place. The lunar variations may be aptly compared to a temperature-compensated pendulum, the D- and EF-regions having slightly different coefficients of expansion. For the sunspot variation of L to be negligible the electrical conductivity of the EF-region must be slightly more variable with sunspot activity than that of the D-region, the coefficients expressing this variation being in the ratio 1·62/1·55 or 1·045. (These figures are in keeping with the known general trend of this coefficient in the ionosphere, Allen[7] finding the ratio 1·045 for the F_1- to E-region coefficients.) For the case of the seasonal variation, ratios of summer/winter conductivity of 2·6 and 2·3 for the D- and EF-regions respectively are required to explain the observed large seasonal variation in the lunar variation. (In this case the analogy with the temperature-compensated pendulum may be preserved by supposing that the two metals have been reversed, thus exaggerating instead of suppressing the variations in length of the pendulum.)

One other notable feature of the lunar variation seems more readily understandable if the above conclusions be accepted. It is known that it increases markedly with increasing magnetic disturbance, but that the rate of increase is greatest when the disturbance activity is small. It is also known that the D-region conductivity increases with magnetic activity, but that there is little effect (possibly even a small decrease) in EF-conductivity. From equation (2) it is readily seen that a given fractional increase in L_D produces a much larger fractional increase in lunar variation when L_D is comparable with L_{EF}. On the other hand, when L_D becomes larger, this magnification falls off rapidly, in keeping with the known behaviour of the lunar variations with increasing disturbance.

This work, which will be published in full elsewhere, is being carried out as part of the research programme of the Radio Research Board of the Council for Scientific and Industrial Research.

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Prof. S. Chapman, through whom Dr. D. F. Martyn has forwarded this letter, remarks that equations (1) and (2) imply horizontal inducing motions due to the sun, in the *D*-, *E*- and *F*-layers, which are in phase with one another, and *lunar* tidal horizontal motions which in the *D*-layer are opposite in phase to those in the *E*- and *F*-layers; on present knowledge (cf. *Nature*, **159**, 357; 1947), this does not seem to be excluded.

Mechanism of the Oxidation of Gaseous Formaldehyde

THE oxidation of gaseous formaldehyde has been studied by Askey[1], Fort and Hinshelwood[2], Bone and Gardner[3], Spence[4], and Snowden and Style[5]. Spence[4] was the first to investigate the reaction comprehensively and to propose a mechanism. Snowden and Style[5] also proposed a somewhat similar but incomplete mechanism. Neither is able to account for a further important observation that has now emerged—first mentioned by Style and Summers[6] and now confirmed by our results—that, concurrently with the oxidation of the formaldehyde, there is a sensitized decomposition to carbon monoxide and hydrogen, linked with it. This decomposition does not take place in the absence of oxygen, and at very low partial pressures of oxygen assumes a relatively predominant role.

It appeared to us that, since formaldehyde may be formally represented as a mixture of hydrogen and carbon monoxide and readily decomposes to these gases, and since its ignition temperature at pressures below atmospheric is of the same order as that for hydrogen–carbon monoxide/oxygen mixtures[7], the mechanism of the homogeneous reaction might well be represented by an adaptation of the schemes employed in the oxidation of hydrogen and hydrogen–carbon monoxide mixtures[8,9]; and on the basis of the previous work and additional results shortly to be published[10] we have been able to show that the oxidation can be described by a mechanism involving hydrogen atoms along the same lines as the hydrogen/oxygen reaction.

Consideration of related reactions, namely, the photolysis and photo-oxidation of formaldehyde, suggests that the reactions

$$\begin{aligned} \mathrm{H} + \mathrm{HCHO} &= \mathrm{H_2} + \mathrm{CHO} \\ \text{and}\quad \mathrm{O} + \mathrm{HCHO} &= \mathrm{OH} + \mathrm{CHO} \end{aligned}$$

may well be involved in the thermal reaction. Since the formyl radical which is precariously stable at 100° C. is almost certainly unstable at the temperatures used for the oxidation (300–340° C.), these equations may be written:

$$\begin{aligned} \mathrm{H} + \mathrm{HCHO} &= \mathrm{H_2} + \mathrm{CO} + \mathrm{H} \\ \text{and}\quad \mathrm{O} + \mathrm{HCHO} &= \mathrm{OH} + \mathrm{CO} + \mathrm{H}, \end{aligned}$$

and a chain reaction scheme involving H, OH and HO_2 can be set up which leads to an expression for the rate which can account for the kinetic results very satisfactorily. The full scheme is as follows:

$$\begin{array}{lll} (1)\ \mathrm{O_2+HCHO=H_2CO_2+O} & k_1 & \multirow{2}{*}{\Big\}\ \text{initiation}} \\ (2)\ \mathrm{O+HCHO=OH+H+CO} & k_2 & \\ (3)\ \dot{\mathrm{H}}\mathrm{+HCHO=H_2+CO+H} & k_3 & \Big\}\ \text{propagation-decomposition} \\ (4)\ \mathrm{OH+HCHO=H_2O+CO+H} & k_4 & \\ (5)\ \mathrm{H+O_2+HCHO=H_2O+CO+OH} & k_5 & \Big\}\ \text{propagation oxidation} \\ (6)\ \mathrm{H+O_2+HCHO=H_2O+CO_2+H} & k_6 & \\ (7)\ \mathrm{H+O_2+O_2=HO_2+O_2} & k_7 & \\ (8)\ \mathrm{H+O_2+}X\mathrm{=HO_2+}X & k_8 & \Big\}\ \text{termination} \\ (9)\ \mathrm{H+O_2+wall=HO_2} & k_9 & \end{array}$$

$$\mathrm{HO_2} + \text{wall} \rightarrow \text{decomposition}.$$

Bowen and Tietz[11] have shown that at low temperatures formaldehyde readily reacts with oxygen to give performic acid, and for the initiation reaction (1) we assume that, at the temperatures involved (c. 350° C.) here, this peracid is not formed but that the normal acid and an oxygen atom are produced instead. Reactions (7), (8) and (9) allow for the fact that the HO_2 radical can only be stabilized in a three-body collision. There is no evidence to indicate that the oxidation involved branched chains at the temperatures at which it has been studied, but the fact that ignition eventually occurs at temperatures in the region of 500° C. can readily be interpreted on the above scheme if the branching reaction $H + O_2 = OH + O$ becomes important at this temperature, a fact already known from the kinetics of the hydrogen/oxygen reaction.

The net overall effects of this chain mechanism are the three complex homogeneous reactions:

$$\begin{aligned} \mathrm{H_2CO} + \mathrm{O_2} &= \mathrm{H_2O} + \mathrm{CO_2} \\ \mathrm{H_2CO} + \tfrac{1}{2}\mathrm{O_2} &= \mathrm{H_2O} + \mathrm{CO} \\ \mathrm{H_2CO} &= \mathrm{H_2} + \mathrm{CO} \end{aligned}$$

in accordance with our experimental results. Of these the second predominates except at very low oxygen concentrations, when the sensitized decomposition reaction becomes relatively more important.

The above scheme leads to the following expression (1) for the disappearance of formaldehyde, $[F]$ referring to the formaldehyde concentration, and S/d being the ratio of surface to volume (S = constant and d = diameter of reaction vessel):

$$-\frac{dF}{dt} = \frac{k_1(2k_5 + k_6)[\mathrm{O_2}]\,[F]^2}{k_7[\mathrm{O_2}] + k_8[X] + k_9[S]/d} + \frac{k_1 k_3 [F]^2}{k_7[\mathrm{O_2}] + k_8[X] + k_9[S]/d} \qquad (1)$$

the first term representing oxidation and the second decomposition. In the absence of inert gas, and in vessels of large diameter with concentrations of oxygen that are not small compared with $[F]$, this expression reduces to an expression for the initial rate as follows:

$$-\frac{dF}{dt} = \frac{k_1(2k_5 + k_6)\,[F]^2}{k_7} \qquad (2)$$

in agreement with previous workers' results; as the products of reaction accumulate the term $k_8[X]$ modifies the later course of the reaction. In vessels of very small diameter, or in packed vessels where S/d is large, the homogeneous reaction is very slow, and this also follows from equation (1). Aside from the fact that they do not account for the sensitized decomposition, the previous schemes in our view are unsatisfactory in that they suggest no initiation reaction and involve a disproportionate number of *ad hoc* assumptions: we believe that the mechanism given above is capable of describing the observed phenomena of this puzzling reaction, and it has the advantage of being in harmony with the analogous reactions of the oxidation of hydrogen and hydrogen–carbon monoxide mixtures, involving practically no additional assumption.

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Some Fatigue Effects on the Human Retina Produced by Using Coloured Lights

When Burch (1898 and 1900) fatigued the human eye by exposure to sunlight through a suitable colour filter, he found evidence for four sensations: red, green, blue and violet, but not for yellow. Edridge-Green and Marshall (1909), after exposing the eye to sodium light, stated that they found definite evidence for a separate yellow sensation. I have recently repeated these experiments, with certain modifications which will be described, and I have arrived at the same conclusion as Edridge-Green and Marshall.

A colour filter was prepared, using gelatin films dyed with Naphthol Green, Malachite Green, Orange G and Naphthol Yellow, which transmitted a narrow lemon-yellow band centred on 0·57 μ. This filter was placed in front of a small lantern condenser behind which was mounted a 36-watt tungsten filament lamp. The observer's eye was carefully adjusted in position until the image of the lamp filament coincided with the pupil, so that a nearly uniform yellow area, subtending about 20 degrees of arc, was presented to his retina. The placing of a disk of ground glass next to the lamp bulb, and the use of a condenser consisting of achromatic lenses, was found to improve the uniformity of the field. (This was particularly useful in the case of the dichromatic filter, which will be referred to shortly.) The use of a dental impression plate for steadying the head is indicated in cases where the observer finds it difficult to preserve the correct eye position.

It was no advantage for the yellow light to be excessively bright; 200–400 ft. c. appeared to be most suitable. If after 15–20 seconds observation it is found to take on a pale lilac tint it is probably too bright and should be reduced. The eye having been exposed to this yellow light for $\frac{1}{2}$–1 minute, a spectrum was examined with as little delay as possible. A simple hand spectroscope was found to be suitable for this purpose. This spectrum should not be too bright; one in which the yellow region has a brightness of 10–20 ft. c. seems to be most suitable.

After exposure to yellow light, as described above, the spectrum was found to be darker than usual in the blue and violet; the red region had a purplish-pink colour, the green appeared pale blue-green, and lying between them was a narrow neutral tint area completely devoid of any yellow colour. On continuing to watch the spectrum the yellow slowly reappears, the red and green gradually lose their bluish hue, the blue and violet recover their usual intensity, but it is some minutes before the normal appearance of the spectrum is reached. Some idea of the extent of these changes after exposure to yellow light, and of the rate of recovery from it, may be obtained by repeatedly comparing the spectrum seen by the exposed eye with that seen by the normal eye.

The tests with the spectroscope were now repeated using a second colour filter, giving a light which closely resembled in brightness and colour, but which was slightly less saturated than, that used in the tests described above; but, instead of transmitting a monochromatic yellow, it transmitted a band in the red, centring on 0·69 μ, and a band in the green, centring on 0·53 μ. On repeating the tests, using this filter, it was found that changes in the appearances of the different parts of the spectrum were much smaller than those just described. Thus yellow was not so saturated in colour, but was not replaced by grey; red and green were less bluish, and the short wave-length end of the spectrum was scarcely altered. In one experiment one eye was exposed to the light from one filter, the other being at the same time exposed to the light from the other filter. On comparing the spectra it was clearly seen how very different they were. Thus these two yellow lights, which resemble one another closely to the eye, produce effects of quite different magnitude on colour vision.

Some further tests were now performed in which colour filters were used, each one transmitting a different narrow spectral band which varied in mean wave-length from 0·69 μ to 0·49 μ. When these were tested in turn for their effects on the spectrum, it was found that the most effective in altering yellow to grey were those which had transmission bands in the yellow and yellow-green. Next came those in the orange and the green; while those with bands at 0·69 μ, and at 0·51 μ and 0·49 μ, had no observable effect on the spectrum colours.

Instead of a spectrum some test colours may be examined, when it will be found after exposing the eye to pure yellow light that red looks crimson, orange looks red, yellow looks grey, green looks pale blue-green, and blue and violet look very dark blue-green.

These experiments confirm the observations of Edridge-Green and Marshall that exposure to monochromatic yellow light causes the eye for a time to see spectral yellow as neutral grey. They show, moreover, that a dichromatic yellow light, consisting of a band in the red and a band in the green, produces results on colour vision which are different from those produced by a monochromatic yellow light which has been adjusted to match it as closely as possible.

Some further tests were now performed. A yellow filter transmitting nearly the entire spectrum, except for the violet and part of the blue, was adjusted to match the monochromatic and dichromatic filters as closely as possible. Exposure of the eye to light which had passed through this filter was found to darken the whole spectrum, but otherwise to have no specific effect on it. A filter transmitting a narrow band at 57 μ and also a band in the greenish-blue from about 50 μ to 45 μ produced no specific effects either. On the other hand, a yellow filter transmitting from about 65 μ to about 55 μ was found to change yellow to grey, and in other ways to produce similar changes to those produced by the monochromatic yellow filter.

The conclusion arrived at is that, while fatiguing the eye to rays from about 65 μ to 55 μ causes changes in the red, the yellow and the green parts of the spectrum, fatiguing the eyes simultaneously to these rays and to greenish-blue rays, produces little or no effect; that is, the latter rays appear to inhibit the onset of the fatigue effects which rays from 65 μ to 55 μ would otherwise produce. The precise spectral limits and other details concerning these inhibitory rays have not yet been determined.

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Experimental Production of a Protostele from a Dictyostele in *Dryopteris aristata*

In leptosporangiate ferns the incipient vascular tissue can be observed as an uninterrupted layer situated immediately below the apical meristem from which it is derived and enclosing a central pith. In this cone of incipient vascular tissue no leaf-gaps are present. The apical meristem can be isolated from the adjacent lateral organs (leaf primordia and scales) and tissues by vertical incisions[1,2]. This operation involves the severance of the incipient vascular tissue, the isolated meristem being now seated on a thin layer of incipient vascular tissue and the latter on a plug of pith parenchyma.

The isolated meristem continues to grow and forms a short shoot on which new leaf primordia later develop. In the lower region of this shoot, above the non-vasculated pith region, the stele is typically solenostelic. This result was predictable from a knowledge of the disposition of the tissue systems at the shoot apex. Since the amount of radial growth at the centre of the shoot is very small it could be further predicted that if the vertical incisions could be made sufficiently close to the apical cell the resulting thin shoot would be protostelic.

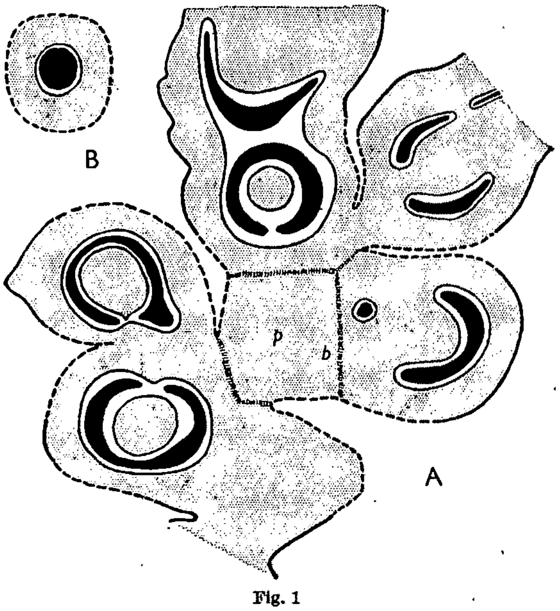

Fig. 1

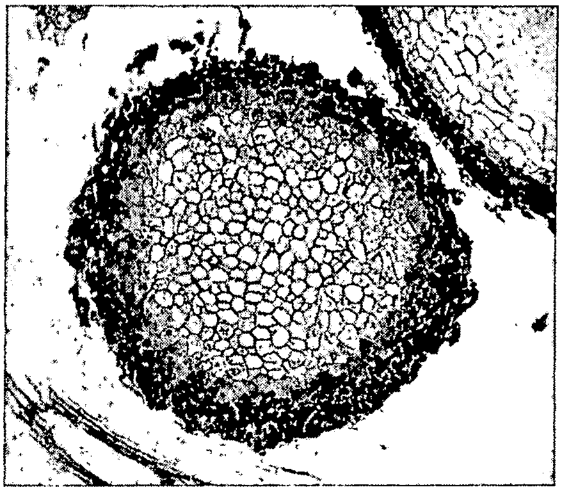

Fig. 2

In practice, this operation is difficult to carry out as the whole meristematic system tends to collapse and become necrotic. However, in the course of these experimental studies, some very small terminal shoots have been obtained, and in one of these the protostelic condition has actually been realized. Fig. 1 *A* shows a cross-section of an incised shoot of *D. aristata* near the base of the incisions (*b*), in the pith (*p*); the outer region of this shoot is almost completely occupied by the bases of the large solenostelic lateral buds which have developed as a result of the experimental treatment[2]. Fig. 1 *B*, taken higher up, shows a cross-section of the small protostelic shoot which has developed from the isolated apical meristem (xylem, black). Near the base of this shoot the stele is a small solenostele; higher up it becomes a medullated protostele (Fig. 4), and still higher up a solid protostele with a central core of xylem (Fig. 3). This shoot became attenuated and later stopped

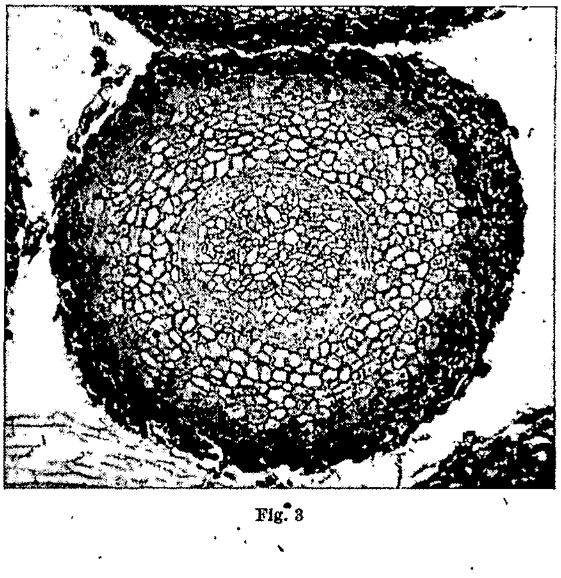

Fig. 3

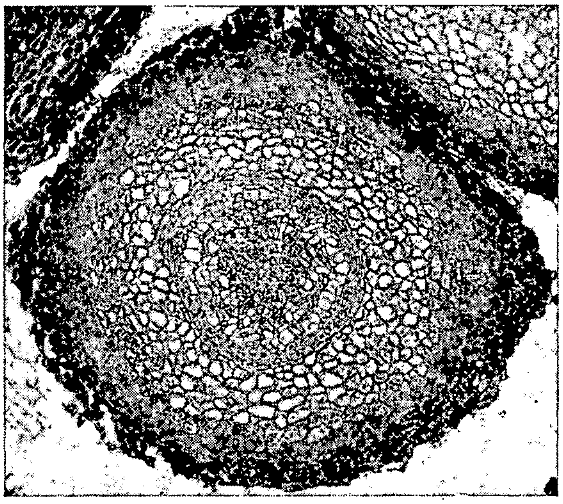

Fig. 4

growing; the meristematic character of the apex was lost and the distal region of the shoot became parenchymatous. Sections taken progressively nearer the distal region showed a decrease in the cross-sectional area of the protostele until eventually it faded out, the whole cross-section of the shoot being occupied by parenchyma, Fig. 2.

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Aug. 6.

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[1] Wardlaw, C. W., *Nature*, **156**, 39 (1945).

[2] Wardlaw, C. W., *Phil. Trans. Roy. Soc.*, B, **232**, 343 (1947).

Carotenoid Pigmentation of Trout

TROUT kept in aquaria and fed on a diet of chopped meat and earthworms lose the brilliant yellow and red pigmentation characteristic of wild fish, but do not appear to suffer any other inconvenience. The xanthophore and erythrophore cells of the dermis become few in number and those remaining contain little pigment. As reported in a separate communication[1], the pigments specifically concerned in these changes are esters of the carotenoids lutein and astaxanthin. The melanophores are not affected. I find that the total carotenoid content of the skin and fins of depigmented fish is about a tenth that of the wild type (see accompanying table). Moreover, all the pigment remaining in the former is lutein, whereas in the latter lutein and astaxanthin (estimated as astacene) are present in much the same concentration. Trout reared from eggs in this laboratory in a balanced tank and fed solely on 'natural' foods consisting of such organisms as they could capture, supplemented from time to time by quantities of live Entomostraca, chiefly *Simocephalus* and *Daphnia* species, and larvæ of *Corethra*, have developed the typical pigmentation of wild fish. They have bright red spots on both sides of the body, the tip of the adipose fin and the dorsal and ventral edges of the tail are also red, the pectoral and pelvic fins are bright orange and the skin of the belly golden. The concentration of carotenoids and the ratio of lutein to astacene are of the same order as found for wild trout.

CAROTENOID VALUES OF THE SKIN AND FINS OF EXPERIMENTAL AND WILD TROUT

	Lutein	Astacene	Total carotenoid (estimated as lutein)
Wild trout	120	75	230
Depigmented trout	20	Negligible	25
Trout reared in aquarium on 'natural' food	90	80	200
Depigmented trout fed on fresh salmon ova for 35 days	80	65	160
Trout fed with pure carotenoids in arachis oil:			
b-carotene	15	Negligible	15
Lutein	30	,,	35
Astacene	20	,,	25

The estimations are based on comparison with standard solutions of lutein and astacene, and were made with a photo-electric colorimeter using a filter with maximum transmission about 480 mμ. All values are expressed as γ per gm. of fresh tissue.

Attempts to increase the carotenoids of depigmented aquarium fish by feeding them earthworms injected with solutions of pure carotenoids in arachis oil have been disappointing. Yearling fish received in this way several milligrams each of *b*-carotene, lutein or astacene—amounts many times greater than the whole carotenoid content of wild fish of the same size. No increase of pigmentation was observed, and the carotenoid content of the skin and fins remained at a low level. On the other hand, a group of depigmented fish fed on whole fresh ova of salmon, which contain considerable amounts of lutein and astacene, as well as carotene in lower concentration, showed a rapid increase in pigmentation of both xanthophores and erythrophores. After 35 days of this diet the carotenoid content of the skin and fins of some fish of this group approached the level found in wild fish. The remainder of the group had become depigmented once more three months after reverting to a diet of meat and worms.

Several possibilities present themselves to account for the failure to effect with preparations of pure carotenoids the degree of pigmentation achieved by a diet of 'natural' foods. Hydroxy-carotenoids usually occur in animal tissues in the form of esters or conjugated with protein, and it would not be surprising if the processes of separation and purification involved irreversible changes in the molecule, rendering it incapable of being utilized by the fish. Astacene at least is known to be a reaction product of astaxanthin, which is itself usually extracted from animal tissues as an ester, and it is possible that lutein also may undergo a similar transformation. Alternatively the efficiency of absorption of the arachis oil solution in the gut of the fish may be very low; no attempt was made in these experiments to measure the amount actually absorbed. Again, there may be a simple quantitative explanation for the failure. Estimations I have made recently of the carotenoids of the stomach contents of freshly caught wild trout have yielded surprisingly high values. The most striking were obtained from fish which had been feeding mainly on *Daphnia longirostra* (18 of 25 fish examined from a single reservoir during June and July). Some stomachs contained as much as 0·25 gm. dry weight of *Daphnia*, and yielded up to 1,200 γ of astacene and 400 γ of xanthophylls, the latter estimated as lutein. These values agree well with those obtained from samples of the zooplankton of the same reservoir, which consisted at the time of about 85 per cent *Daphnia longirostra*, the rest mainly *Cyclops* species, and which gave 6,520 γ of astacene, 1,385 γ of xanthophylls and 120 γ of carotenes per gm. dry weight. Clearly the quantities of carotenoids ingested by fish feeding on such a rich source, neglecting any derived from other food, are much greater than the limited amounts of crystalline preparations with which it has so far been possible to supply them. It may well be that even in wild trout the efficiency of absorption of carotenoids is low, or that much of it is utilized in other ways, of which the only example we have any knowledge at present is the conversion of some carotenes to the vitamins A. If this is the case, the proportion available to the chromatophore cells may be small even under the most favourable conditions.

It is hoped to publish later a more detailed account of these and further experiments.

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[1] Steven, D. M., *Nature*, [160, 507 (1947)].

Spontaneous Occurrence in *Lythrum salicaria* of Plants Duplex for the Short-style Gene

The continuation of the work with the purple loosestrife, *Lythrum salicaria*, previously reported[1-4], has confirmed the tetrasomic inheritance of the factor for mid-style. Lacour's determination of the somatic chromosome number as sixty suggests, therefore, the existence of fifteen quadruplets of homologous chromosomes. Since the short style is epistatic to mid, it is possible by legitimate crosses between short- and mid-styled plants to build up genetic constitutions up to four genes for the mid-style; all these appear to be phenotypically alike, or, in other words, the mid-style gene appears to be completely dominant.

In legitimate pollination not more than one parent can be short. Many shorts tested by crosses with long-styled plants have shown themselves to be simplex, containing only a single gene for short-style. Illegitimate short-by-short matings offer peculiar difficulties, and have so far been unsuccessful. It is theoretically possible, however, that simplex short plants should produce, by a process of double reduction, a minority of duplex gametes.

Recent tests involving a large number of second backcross progenies have shown that this does actually occur, and have provided a source of material duplex for short, which is of immediate importance in studying the relations of the genes for short and for purple (*v* pink) flowers which are linked in inheritance. The first indication was a small progeny grown in 1946 giving

Short purple	Short pink	Non-short purple	Non-short pink	Total
24	9	0	5	38

In the light of the larger progeny grown this year from the same plant as seed parent, crossed with pink longs, there can be little doubt that in the chromosomes carrying short its constitution is

$$RS/rS/rs/rs,$$

where R stands for purple, r for pink. It is also duplex M_2m_2 at the mid locus.

This year's progeny has yielded

Short purple	Short pink	Non-short purple	Non-short pink	Total
68	55	4	13	140

About fifty of the short purples from these have been crossed to long pinks to determine the relative frequencies of the ten possible types of gamete. The changed ratio of pink to purple is probably due to better scoring of this rather difficult factor.

One consequence of this finding is that wild cross-pollinated populations must contain, in very unequal numbers, fifteen different genotypes in respect of the factors for mid- and short-style. Of these, one only is long-styled, four are mid-styled and ten short-styled. The approximate relative frequencies to be expected in Nature are given in the accompanying table for a population of 1,000.

		s_4	Ss_3 Short	S_2s_2 Short
m_4	Long	333·3	177·4	2·248
Mm_3	Mid	275·9	113·3	1·435
M_2m_2	Mid	52·14	33·23	0·421
M_3m	Mid	4·925	4·862	0·062
M_4	Mid	0·324	0·320	0·004

No plants triplex or quadruplex for short can be produced by legitimate pollination.

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[2] Fisher, R. A., and Mather, K., *Nature*, 146, 521 (1940).

[3] Fisher, R. A., and Mather, K., *Nature*, 150, 430 (1942).

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Gonadal Hormones and Mineral Balance in the Domestic Fowl

It is established that the pullet coming towards the beginning of laying begins to retain calcium and phosphorus at an increasing rate[1,2]. In some cases the rate of retention may be of the order of 0·4–0·5 gm. calcium per diem.

We have sought to imitate this effect in the sexually immature pullet (aged 10–14 weeks) by means of gonadal hormones. The hormones were normally administered in six equal doses on alternate days over a twelve-day period. Œstradiol dipropionate (Ciba) alone to total amounts of 6 mgm., 12 mgm. or 24 mgm., or testosterone propionate alone to total amounts of 8 or 4·5 mgm., failed to increase the rates of retention of calcium and phosphorus significantly over those shown by control pullets. When the œstradiol dipropionate treatments were combined with the testosterone propionate treatment, then the rates of calcium and phosphorus retentions were increased over those shown by the controls to a highly significant degree. No analogous effect was shown by testosterone propionate in respect of the elevation of serum calcium and plasma phosphorus fractions evoked by the œstrogen treatments, although the combined œstrogen and androgen treatments intensified the hypertrophy of the oviduct induced by œstrogen.

The only previous experiments known to us on the effects of gonadal hormones on the calcium balance of birds are those of Clavert and Benoit[3], who secured a sharp increase in calcium retention by adult male pigeons following a single injection of 0·5 mgm. œstradiol dipropionate. It remains uncertain, however, how far the results of their experiments were conditioned by the possible presence of endogenous androgen. We are inclined to the view, therefore, that the increased rates of retention of calcium and phosphorus which take place during the

10–14 days before the pullet begins laying are conditioned by androgen as well as by œstrogen, and that the well-known androgen activity in the sexually maturing pullet (manifested by the familiar reddening and hypertrophy of the comb at the outset of laying) has a physiological significance in relation to calcium metabolism.

In the course of our work we have noted that the œstrogen treatments, while raising the serum calcium, serum riboflavin[4] and plasma inorganic lipid and phosphoprotein phosphorus, nevertheless bring about a decrease in serum citric acid concentration. Citric acid is related on one hand to skeletal metabolism[5] and on the other to gonadal hormone activity, for Shorr, Bernheim and Taussky[6] have shown that œstradiol benzoate increases citric acid excretion in women.

We hope to publish a fuller account of this work at a later date.

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July 4.

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Use of Small-size Plots in Yield Surveys

I am glad that my note[1] has induced Prof. Mahalanobis to set down his results on plot-size bias[2]. Since the publication of his paper on the Bihar Crop Survey (1945), the position has gradually altered. In 1946 Prof. Mahalanobis recommended plots ranging from 50 to 100 sq. ft. [3] without giving any reasons or experimental data for discarding plots smaller than 50 sq. ft. In his present note the range has been further extended to include plots of 200 sq. ft., and the standard procedure adopted at present is stated to be to obtain concentric circles of 12·57, 50·27, 100·88 and 201·06 sq. ft. The advantage claimed in favour of these circles is that the variation in yield between sub-samples supplies an excellent internal control. Whether this refers to the variation in the estimates of yield or of variability from different sub-samples, the advantage does not really exist, because the estimates of variability as well as those of average yield are found to be biased in the case of small-size plots[4].

The principal advantage of small plots of the size used by Hubback and by English and American workers is that their produce can be handled by the experimenter himself without the use of hired labour. This advantage is of no effect with the concentric sub-samples at present used by Prof. Mahalanobis. Indeed, apart from being agriculturally inconvenient, as pointed out by Dr. Panse[5], the cost and effort involved in harvesting them would far exceed that required for harvesting a single large plot of 1/80 acre as adopted in the Indian Council of Agricultural Research surveys. Further, as labour is paid on a daily and not hourly basis under Indian conditions, the cost of harvesting is also not affected by small variations in size.

The limit at which the bias becomes negligible will vary with the crop and the agency carrying out the experiments. Even if it is demonstrated that plots of, say, 50 sq. ft. give unbiased estimates when handled by trained statisticians, this would be of limited practical value, especially in India, where the employment of a special agency is out of the question and the experiments have necessarily to be carried out by the local departmental staff in the course of their normal duties. All the investigations carried out by the Indian Council of Agricultural Research were planned with this objective in view. The results show that even with the best supervision and training it is not unlikely that plots up to 200 sq. ft. may give biased results. In the experiments reported by Dr. Panse, plots of 218 sq. ft. were found to give an over-estimate of yield. These results conclusively support the adoption of large plots of the size 1/80 acre or thereabout adopted by the Indian Council of Agricultural Research in its yield surveys.

On the question of the explanation of the observed bias, Prof. Mahalanobis suggests that the bias is more likely to be due to the experimenter tending to favour more fertile patches by shifting the exact location of the random point in the field than to the unconscious inclusion of the border plants inside the plot. I do not share this view. In the experiments conducted in Moradabad District, the starting point of the plot was located, by means of a pair of random numbers, under the direct supervision of statistical officers. Bias would appear to arise from the fact that even when the point of location is randomly fixed under adequate supervision, the field worker inevitably encounters a difficulty in deciding whether to include the border plants inside the plot or to exclude them. As the contribution of even a single plant to the harvested produce is appreciable in small plots, it is to be expected that the tendency regarding unconscious inclusion (or exclusion) of border plants inside the plot should materially influence the yield estimates. That appears to me the real explanation of the observed over- or under-estimation in experiments with small plots.

The danger of under-estimation due to the sagging of stretched ropes in using comparatively large plots to which Prof. Mahalanobis refers exists only in theory; for sagging is only one of the large number of small compensating errors arising in the marking of the plot. The net result of these errors is negligible in comparison with the amount of harvested produce when the plot size is sufficiently large, as will be clear from my own results[6], which show that the yield estimates from 1/80 acre plots are in agreement with those from harvesting the whole field and, therefore, free from bias. The actual existence of under- or over-estimation from any source has to be established by experimentation.

Prof. Mahalanobis has also raised the question of the reliability of the results and has emphasized the importance of arranging work in the form of interpenetrating samples. This point is not relevant to the subject-matter under discussion; but in my opinion these checks are not of any value in providing evidence on the reliability of field work. This point will be discussed elsewhere.

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[3] Mahalanobis, P. C., *Sankhya*, **7**, 3, 269.
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FRIEDEL-CRAFTS CATALYSTS IN POLYMERIZATION

KINETIC MEASUREMENTS AND THE ROLE OF WATER

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THERE has been reported a critical minimum catalyst concentration of 0·03 per cent in the low-temperature polymerization of isobutene in the liquid phase using boron trifluoride, aluminium chloride or titanium tetrachloride as Friedel-Crafts catalyst[1]. Direct mixing in the liquid phase is, however, impracticable owing to the great velocity of reaction, and any results obtained in this way are subject to uncertainty. In the work described below we have succeeded in devising a technique which enables a mixture of monomer and catalyst to be prepared at temperatures below their reaction point. Their vapours are mixed at pressures measured directly on a glass spoon gauge[2], and the gaseous mixture slowly frozen to the solid state in liquid air. At this temperature there is no reaction, but when a mixture of boron trifluoride and isobutene prepared in this way was allowed to warm up to −140° C. (the melting-point of isobutene) very rapid polymerization suddenly set in, as was indicated by a sharp rise in the temperature recorded by a copper-constantan thermocouple. We were able to show that the minimum concentration of boron trifluoride required is dependent on the degree of purification of the reactants, a value of 0·03 per cent boron trifluoride being reduced to 0·006 per cent by repeated distillation.

Because of the difficulty of obtaining kinetic measurements for the fast reaction in the liquid phase, a less active catalyst was sought. Measurable rates were obtained with stannic chloride, the polar diluent ethyl chloride being used to keep the system homogeneous. It soon became apparent, as has also been found qualitatively by Plesch, Polanyi and Skinner[4] using titanium chloride as catalyst, that the presence of water in the system is paramount, and the following measurements were therefore carried out to determine quantitatively the effect of metallic halide, and water as co-catalyst on the reaction.

The reaction was followed by a dilatometric method. For this purpose the components, including water, at measured pressures in the gas phase were frozen down separately into a special form of dilatometer; this could be sealed off from the apparatus and was so constructed as to allow of mixing by shaking. The rates of reaction were followed at a temperature of −78·5° C. afforded by solid carbon dioxide and ether. There is no induction period, and a decrease in volume occurs which is here assumed proportional to the extent of polymerization. (Owing to adsorption, water vapour in a glass apparatus does not obey Boyle's Law; by coating the inside of the apparatus with a hydrophobic monolayer in the manner described by us[3] this difficulty was overcome, and the pressure gave an accurate measure of the quantity of water added to the system.)

All materials were purified by repeated distillation *in vacuo*, but there were still minute quantities of impurities (including water) in the monomer and diluent, and it is probable that these have some effect on the course of the reaction.

For stannic chloride 1·15 per cent, isobutene 20 per cent, ethyl chloride 78·8 per cent, and a reaction temperature of −78·5° C., the effect of added water up to 0·43 per cent on the initial rate of polymerization is shown in Fig. 1.

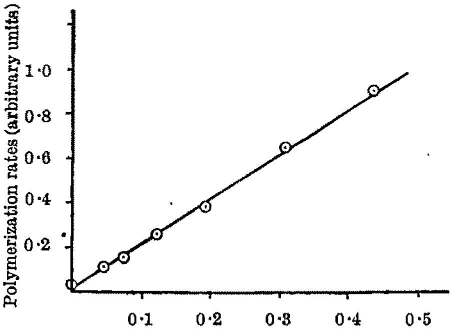


Fig. 1

Even in the absence of added water, there is still a rate of polymerization corresponding to the presence of about 0·015 per cent water. The graph clearly shows, however, the importance of water on the mechanism of the reaction.

The effect of stannic chloride concentration on the reaction rate is shown in Fig. 2.

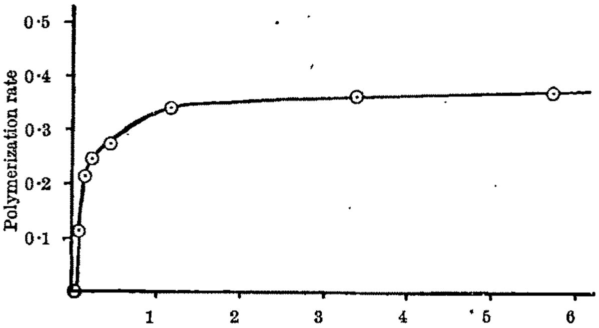


Fig. 2

It is clear that both water and the metallic halide are essential to the catalysed reaction in the liquid phase, and we conclude that a soluble hydrate is formed and functions as the active catalyst. The minimum concentration of metallic chloride below which no polymerization occurs is rather less than half the percentage of added water. When the concentration of stannic chloride was less than about one fifth that of the added water, a white solid was observed at the bottom of the dilatometer. Thus the minimum catalyst concentration is probably due to the removal of the metallic halide by excess water to give an insoluble hydrate with no catalytic activity, and should be dependent on the concentration of water in the system. Then, as the concentration of the stannic chloride increases relative to the water, there comes a stage when a lower, soluble, catalytically effective hydrate is formed, perhaps conforming to a mass action law. With more than 1 per cent stannic chloride, and 0·18 per cent of water, the rate does not increase appreciably. The precise nature of the hydrate is not certain, but neither a monohydrate nor a dihydrate is excluded by the results expressed in the graph.

When the monomer concentration is increased, the normal effect on the rate may be masked by the decrease in dielectric constant of the system and the reduced solubility of the hydrate. With 1·15 per cent stannic chloride and 0·18 per cent water the variation in rate with monomer concentration is shown in Fig. 3.

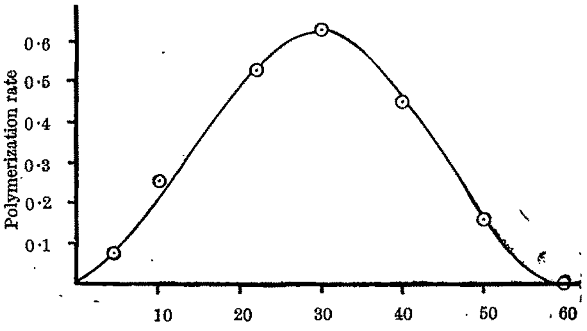


Fig. 3

A maximum rate is observed with 30 per cent monomer; there is no indication of a threshold concentration of 10 per cent isobutene referred to by Plesch, Polanyi and Skinner[4]. Since the dielectric constant of the medium changes rapidly with monomer concentration, a means of keeping it constant must be devised before the quantitative dependence of rate on monomer concentration can be given.

The effect on the rate of polymerization of the inhibitors ethyl alcohol, tertiary butyl alcohol, diethyl ether, and acetone was investigated by adding 0·3 per cent of each to a reaction mixture already containing 0·18 per cent water. The mixtures were not always homogeneous because of the low solubilities of the complexes at −78·5° C. All these substances reduced the rate to less than one fifth of its normal value, and it was observed that the molecular weight was also considerably reduced. The hydrocarbons 1-butene and 2-butene halved the normal rate with concentrations of 2 and 6 per cent respectively.

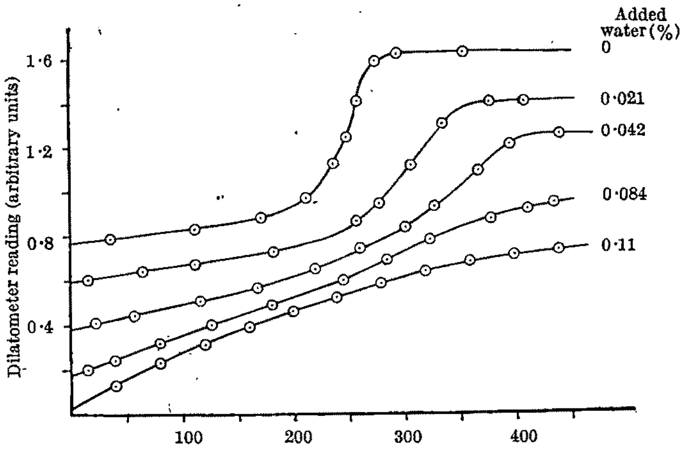
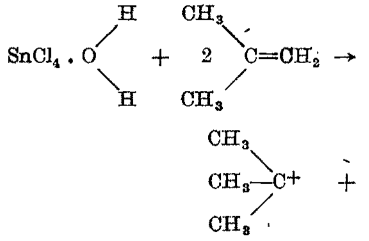


Fig. 4. Common origin moved for clarity

In the absence of added water, no polymerization was observed when 0·3 per cent of ethyl alcohol, tertiary butyl alcohol, diethyl ether and acetone were added to 1·15 per cent stannic chloride and 20 per cent monomer in ethyl chloride. It is therefore probable that these substances cannot replace water as co-catalysts in low-temperature polymerization.

Polymerizations involving very small quantities of added water (less than 0·1 per cent) have been followed through to completion, and the course of the reactions is shown in Fig. 4. The rates of reaction in those systems containing the least water are subject to an acceleration in the later stages of the reaction, the acceleration occurring the sooner and being the more marked the lower the concentration of water. This is reminiscent of a similar phenomenon observed in the free radical polymerization of methyl methacrylate, and shown by Norrish and Smith to be due to a decrease in the coefficient of chain termination consequent upon the considerable increase in viscosity of the medium in the later stages of reaction[5]. It is probable that a similar explanation holds here, for the chain-length and the consequent increase in viscosity are found to be greater the smaller the content of water.

A tentative picture of the kinetic mechanism may be achieved if we assume that chain propagation is initiated both by positive and negative ions derived from the hydrated stannic chloride; for example:



Chain propagation then occurs by successive addition of monomer units to the ionized complexes so that there are both positive and negative growing chains; and if termination results from the mutual neutralization of oppositely charged chains it can be understood how the coefficient of termination can decrease with increasing viscosity.

It can be shown that under such conditions the rate of polymerization is proportional to the square root of concentration of catalyst. The results obtained above are in agreement with the conclusion that the concentration of catalyst is proportional to the square of the concentration of water and the first power of the stannic chloride. When, however, the latter is in large excess, the concentration of catalyst is controlled by the water and is independent of the metallic halide. It is conceivable that the equilibrium

$$SnCl_4 + 2H_2O \rightleftharpoons SnCl_4 . 2H_2O$$

would conform to these requirements; but further evidence is required and any definite conclusion must be held in suspense.

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[3] Norrish and Russell, *Nature*, **160**, 57 (1947).

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A RADIO-FREQUENCY ION SOURCE WITH HIGH PERCENTAGE YIELD OF PROTONS

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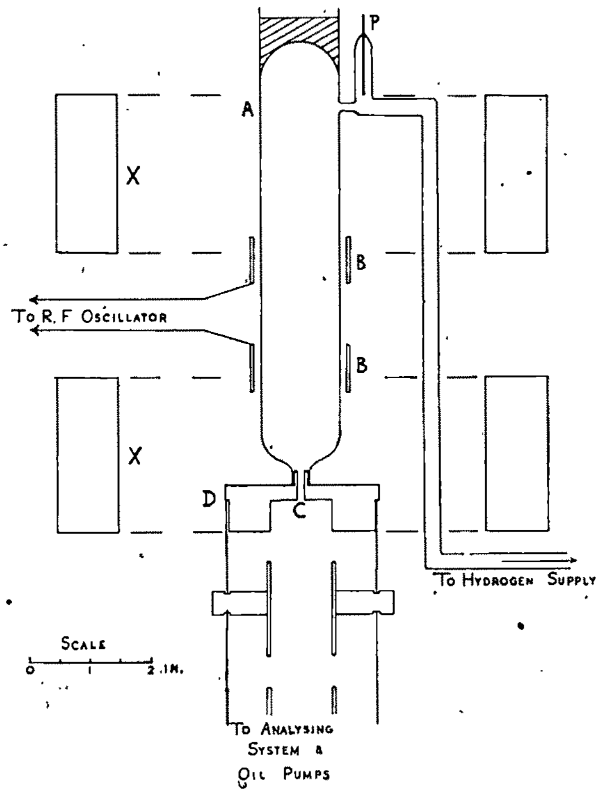
Department of Natural Philosophy, University of Glasgow

IN a recent communication in *Nature*[1] a description was given of a new type of ion source. This source gave a high beam current for a low energy input, but no results were given for the yield of protons as compared with diatomic (H_2^+) and triatomic (H_3^+) ions. We have recently undertaken an investigation of ion sources with the object of making a source suitable for use with a 1 MV. accelerator tube, and throughout these investigations have made quantitative measurements of the percentage yield of protons by magnetic resolution of the beam. Using the source described by Thoneman[1], we were unable to obtain more than 5 per cent of the beam as protons, the remainder being approximately equally divided between H_2^+ and H_3^+ ions.

We conclude from our investigations that the following conditions are necessary for the production of a high percentage yield of protons in discharges at pressures of the order of 10–50 microns: (i) The walls of the vessel in which the discharge takes place must be made of clean glass, and the area of metal exposed to the discharge should be kept to a minimum, presumably in order that the recombination of atomic hydrogen shall be reduced as much as possible. (ii) The ionization density in the discharge should be as high as possible.

The diagram shows an experimental arrangement satisfying these conditions which gives satisfactory results. The discharge is maintained in a 'Pyrex' tube *A*, 1¼ in. in diameter, by a radio-frequency voltage at a frequency of 180 mc./sec. applied between two external cylindrical brass electrodes *B B*. A pair of Helmholtz coils *X X* provide a constant magnetic field, adjustable from 0 to 300 gauss, parallel to the axis of the discharge tube. When the magnetic field is raised gradually from zero, a critical value of the order of 100 gauss is reached at which the brightness of the discharge increases and the colour shows a very marked reddening. The effect of the magnetic field is presumably to maintain the path of the electrons, which are oscillating under the influence of the radio-frequency field, along the axis of the discharge tube, and hence increase their life-time for producing ionization. This resultant increase in ionization density causes an increase in the percentage of atomic hydrogen in the discharge tube, which shows itself as an increase in the intensity of the Balmer spectrum relative to the molecular spectrum and hence as a reddening of the colour. We have found that this reddening is always associated with an increase in the measured proton percentage in the emergent beam, and may say in general that a steely blue colour indicates less than 20 per cent protons and a bright red colour indicates more than 50 per cent protons. Increase of the magnetic field beyond this critical value gives no appreciable increase of proton yield.

The ions are extracted from the discharge through the exit canal *C*, ⅛ in. in diameter by ½ in. long, in the aluminium block *D* by applying a potential of the order of 3 kV. between it and the probe *P*. The tungsten probe is set back in the side tube through which the hydrogen enters the discharge tube in order to minimize its effect as a surface for recombination of atomic hydrogen. Secondary electrons which are produced by ions striking the walls of the exit canal are accelerated up the axis of the discharge tube, and it was found necessary to cool the top of the tube with a small oil bath. For analysis the emergent beam is accelerated, usually to 15 kV., by an electrostatic lens system which focuses it on to a slit, ¼ in. wide, at a distance of 36 cm. from the exit canal *C*. The beam passes through the slit into a Faraday cylinder. A 'straight through' analyser, with crossed magnetic and electrostatic deflecting fields, is built in between the focusing system and the slit, at a mean distance of 23 cm. from the slit. A small permanent magnet provides the magnetic deflecting field of about 400 gauss over a distance of 1¼ in. The electrostatic field is provided by two parallel plates 1¼ in. long, spaced ¾ in. apart, between which deflecting potentials up to 3 kV. can be applied.



Typical operating conditions for the source shown in the diagram are as follows: radio-frequency power into the source 30 watts, magnetic field 130 gauss, pressure ~15 microns, hydrogen consumption 15 c.c./hr., probe potential 2·8 kV., focusing potential 14 kV., probe current 6 ma., total focused beam current to Faraday cylinder 400 μa., resolved proton current 240 μa., resolved diatomic ion current 110 μa., resolved triatomic ion current 12 μa., resolved current of heavy ions 40 μa. It will be seen that protons comprise 60 per cent of the emergent beam.

To illustrate the importance of reducing the area of exposed metal surfaces to a minimum, we may mention that we have obtained proton percentages as high as 75 in an earlier source in which the ions were extracted through a hole ⅛ in. in diameter in the glass end of the discharge tube, although, in this particular case, we were unable to obtain beam currents in excess of 50 μa. In the source shown in the diagram, the outside diameter of the top of the aluminium exit canal exposed to the discharge was 3/16 in.

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* Nuffield Fellow.

We believe that proton currents of considerably more than 240 μa. can be obtained with this type of source by improvement of the extraction and focusing arrangements and increase of radio-frequency power.

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[1] *Nature*, 158, 61 (1946).

PSYCHROMETRIC OBSERVATIONS IN THE LOWER ATMOSPHERE

A VERY valuable series of nearly five hundred psychrometric measurements in the lowest 1,000 ft. of the atmosphere were made over Massachusetts Bay, under the general direction of Mr. Donald E. Kerr, by members of the Radiation Laboratory, Massachusetts Institute of Technology, in the summer and autumn of 1944. They are discussed by Richard A. Craig in *Papers in Physical Oceanography and Meteorology*, **10**, No. 1, published by Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, also described as "Contribution No. 362 from the Woods Hole Oceanographic Institution", which is dated November 1946.

These measurements were not made primarily for their meteorological interest, but in connexion with studies concerning the propagation near the sea surface of radio waves of the order of centimetres or a few metres in length, because they yielded information about vertical distributions of refractive index of air for radio frequencies. The necessity for these special observations arose because the kite soundings made by G. I. Taylor in 1913 from the whaling ship *Scotia* over the Grand Banks of Newfoundland, and those made in 1915 on the U.S. Coastguard cutter *Seneca* for a more extended area, did not show the vertical distributions of temperature and humidity in sufficient detail to help very much in the propagation problem. The discussion is in two parts. Part 1 describes the organisation of the work and some of the thermodynamics and kinematics involved in such studies. It also describes the method of presentation adopted in Part 2, where fifty-one selected soundings are discussed with all available supplementary information, such as the past history of the air currents at different levels and synchronous observations made at shore stations.

A psychrograph which measured dry- and wet-bulb temperatures by means of electrical resistors was developed for the work. It is referred to as the M.I.T. psychrograph (Kerr, 1947) but is not here described in detail. It was mounted for the most part on a Curtiss monoplane or a twin-engined Beechcraft, but for a few of the soundings was hung beneath a slowly ascending Navy airship. Meteorological investigations on such a lavish scale are scarcely likely to be undertaken in Great Britain for many years to come. They are a good example of the American flair for well-organised co-operative research. At the same time, we may take pride in the fact that the influence of Taylor on meteorological theory arising originally from his theoretical treatment in 1913–14 (when he was Schuster reader in meteorology at Cambridge) of the kite ascents made on the *Scotia*, has not lessened in the intervening thirty-three years. This is illustrated by the use made by Craig, in the discussion of these American soundings, of Taylor's development of the theory of mixing of air masses of different temperature and vapour pressure.

Although no single point of outstanding meteorological interest is brought to light by the soundings in Massachusetts Bay, no serious student of synoptic meteorology can afford to overlook them, because of the insight which they give into the changes that are always taking place in air masses as a result of radiation, conduction and turbulence, as they pass over land and sea, or over seas in which there is a steep horizontal gradient of temperature. A good proportion of the soundings were made in fog, and these are of particular value in connexion with forecasting.

THE MILLPORT MARINE BIOLOGICAL LABORATORY

EVIDENCE of increasing activity in the field of marine biological research is afforded in the annual report of the Scottish Marine Biological Association for the year 1945–46. Research at the Millport Laboratory under the direction of Mr. R. Elmhirst has during the year in question covered a number of problems the solution of which has direct economic value.

Work on British agar, for the development of which we are indebted to Dr. S. M. Marshall and Dr. A. P. Orr, has been continued on collections of *Chondrus crispus* from Wales and Cornwall. The agar from *Chondrus*, like that from *Gigartina*, is satisfactory for bacteriological work, and there is also a considerable commercial outlet for a dried preparation of the viscous extract obtained from these weeds by boiling. The commercial harvesting of *Gigartina* in the Clyde area has become a regular summer occupation for local people.

Dr. Marshall and Dr. Orr have also made further experiments on the effects of different fertilizers on the phytoplankton in Loch Craiglin, and on the growth of oysters. It was found that oysters could be satisfactorily fattened in containers put out in Loch Sween. The oysters were well filled and of excellent flavour.

There is also promise of a possibility of breeding oysters successfully in the area, though the year may have been unusually suitable owing to the exceptionally fine summer.

The team of workers on antifouling research led by Mr. K. A. Pyefinch, and previously under the Iron and Steel Institute, passed on January 1, 1946, to the control of the British Iron and Steel Research Association. During the year a general report was produced including an account of the biology of the more common fouling organisms. A paper has also been published on "Methods of Assessment of Antifouling Compositions". Some interesting biological details are given in the annual report under review, including the biology and settlement of *Tubularia* larvæ and the settlement of marine worms. The latter indicates the probability of the importance of the physical nature of the substratum in influencing settlement as shown by the pioneer work on metamorphosis in polychæte larvæ by D. P. Wilson.

The report also contains summaries of research on the ecology of Mollusca carried out by Prof. C. M. Yonge and Dr. A. C. Stephen.

It is satisfactory to note that a number of visiting research workers went to Millport during the year, and that there are general signs of increasing post-war activity. The Millport Laboratory is situated in an area with much sheltered water and an abundant flora and fauna. It is most suitably placed for research of many kinds, and is within easy reach of deeper oceanic water with its rich and varied fauna. It is to be hoped, therefore, that in order to cope with the increasing demands for marine biological research in the British Isles we shall see in the near future an expansion of the staff and equipment at Millport. Included with the equipment should be a larger research vessel in order that the range of observations at sea may be extended.

MANAGEMENT OF RESEARCH

THE lecture on "The Organisation of Industrial Research" which Dr. R. P. Russell, president of the Standard Oil Development Co., delivered on June 9 to the Industrial Research Committee of the Federation of British Industries was far more than a factual review of one of the world's largest research organisations or its achievements in the petroleum industry: it was a masterly analysis of factors and conditions determining the success of industrial research in any field and an outstanding contribution to what may be termed the philosophy of research. Research activity in his own Company, he said, began in 1919 with a group of twenty-six people: to-day the staff includes 2,456 technologists, engineers, assistants and clerical personnel all engaged exclusively on research and development projects, as well as several hundred working on laboratory phases of direct operating problems and an engineering staff of more than five hundred. Dr. Russell computed that this expansion had brought a return of £15,400 of additional profit for each £1,000 expended on research and development, and he believes that without research and development any company or industry would stagnate and in time lose most of its business to more far-sighted competitors.

Dr. Russell does not, however, claim that research is a universal panacea or even that it is the keystone in the arch of industrial production. It is rather one link in a chain which comprises also natural and human resources, production management, effective sales and distribution and courageous executive management. Nor is the 'economic climate' alone important: a sound 'political climate' is also an important factor in successful industrial enterprise, for such a climate inspires the sense of security which gives people confidence to assume the risks involved in any important new venture. These factors are all important and must be firmly interlinked if our objectives of satisfying human needs are to be achieved. Progress depends essentially on whether our political and economic system strengthens or weakens the factors which form the links in the industrial chain.

At the outset, Dr. Russell disposes of the idea that adequate expenditure of money or of men on research is all that is required. It is a matter of team-work and co-operation and of ensuring the conditions most favourable to the generation of ideas. Effective co-operation, for example, in the solution of a research or development problem means that everyone participating knows the problems which exist and recognizes their relative importance. This applies no less to the engineering organisation, the production group and management than to the research and development team itself, and the first point which Dr. Russell makes is that information about a project on which the research organisation is engaged must flow freely throughout the whole organisation, horizontally as well as vertically. Insulation of the research and development department must be avoided at all cost, and continuing contacts fostered at each operating level.

The interlacing of information in this way is not only a valuable incentive but also has certain practical advantages in facilitating the rapid application to one project of new knowledge gained by other units. Nor is the exchange of information confined within the firm. Dr. Russell stresses the value of close contact with work going on outside, of attendance at scientific and technical meetings and of the use of consultants as well as research agreements with universities, sometimes on very broad lines and sometimes for specific problems of immediate importance. Here Dr. Russell makes no distinction between fundamental and fact-finding research, and the value of the universities as the centre of the search for knowledge for its own sake is rather taken for granted. Expenditure of his Company on research by outside consultants amounts to about two per cent, and on research grants to universities to more than three per cent, of the total salaries of the technical and professional staff. Apart from this, research workers are encouraged to devote about ten per cent of their time to work on original ideas; and while the value of competition as a stimulus is fully appreciated and encouraged within the firm itself, the practice is never allowed to impede the free and complete flow of all information from unit to unit.

Dr. Russell indicates clearly the relations of mutual trust which exist in the research organisation he describes, and that positive factor is one the importance of which can scarcely be exaggerated. In itself it fosters the sense of individual responsibility which calls forth the maximum ingenuity and initiative; and in establishing the right atmosphere it probably contributes even more than the study of individual characteristics and capabilities, though that, too, is important. No less important than encouraging the generation of ideas is the avoiding of practices which tend to discourage them, and some of the observations Dr. Russell makes here are substantiated by bitter experience in Great Britain between the two World Wars. As he truly remarks, the loss of morale and effectiveness through a sudden and drastic reduction of the technical staff is out of all proportion to the monetary saving achieved.

There is much in this lecture for those responsible for the management of research to ponder, all the more in that Dr. Russell recognizes that, in the United States as in the United Kingdom for some years to come, the available scientific man-power will be insufficient to meet all the demands for trained staff, and it will be imperative to ensure that the best possible use is made of the resources that are available. Nor is it a matter for the industrialist alone. It is not necessary to go all the way with Dr. Russell in his belief in the necessity for a free and truly competitive system to agree with him that political conditions can be of great importance from the point of view of incentives. The idea of public service, as Sir Oliver Franks noted in his recent lectures, can be at least as satisfying an incentive as the purely financial one.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 20

King's College (in the Department of Civil and Mechanical Engineering, Strand, London, W.C.2), at 5.30 p.m.—Prof. S. J. Davies: "Mechanical Aids to Improved Thermal Operations". (Further lectures on October 27, November 3, 10 and 17. The lecture on November 10 will be given by Mr. L. J. Clark, who will deal with Special Considerations in the Production of Gas for Towns.)*

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the Luton Scientific Association, in the Lecture Hall, Public Library, Luton), at 7.30 p.m.—Films and Discussion on Water Treatment.

Chemical Engineering Group (joint meeting with the Yorkshire Section of the Society of Chemical Industry, at Leeds).—Mr. H. C. Millett: "Some Experiences in the Heavy Chemical Industry" (preceded by a visit to Charles Brotherton Chemical Engineering Laboratory).

Tuesday, October 21

University of London (at the Royal Holloway College, Englefield Green, Surrey), at 2 p.m.—Prof. S. Tolansky: "Recent Developments in Multiple Beam Interferometry". (Further lectures on November 4, 11, 18, 25 and December 2.)

Society of Chemical Industry, Agriculture Group (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. G. A. Cowie: "Fertilizer Requirements of Wheat as Determined by Field Trials".*

Institution of Post Office Electrical Engineers (at the L.T.R. Headquarters Refreshment Club, Waterloo Bridge House, London, S.E.1), at 5 p.m.—Mr. W. H. Scrivener: "Engineering Control Statistics—Some Difficulties and Possible Solutions".

University College London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. Bernard Katz: "Transmission and Excitation in Nerve and Muscle". (Further lectures on October 28, November 4, 11, 18 and 25.)*

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. B. S. Bramwell: "Galton's 'Hereditary Genius' and the Three Following Generations since 1869".*

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. H. E. Hogben: "Modern Aids to Navigation by Radio".

Society of Engineers (at 17 Victoria Street, London, S.W.1), at 6.30 p.m.—Dr. G. E. Blythe: "Fine Grinding in Industry".

Wednesday, October 22

Manchester Joint Research Council (in the Albert Hall, Peter Street, Manchester), at 10.30 a.m.—Conference on "Market Research".

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. —Prof. W. J. John: Inaugural Address as Chairman.

Society of Chemical Industry (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Sir Frederick Keeble: "Some Aspects of the Work of H. E. Armstrong" (Second H. E. Armstrong Memorial Lecture).

Thursday, October 23

Chemical Society (joint meeting with the Hull and District Section of the Royal Institute of Chemistry and the University College Scientific Society, in University College, Hull), at 6 p.m.—Prof. D. H. Hey: "Addition Polymerisation".

Royal Aeronautical Society (in the Lecture Hall of the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Sir William T. Griffiths: "The Problem of High Temperature Alloys for Gas Turbines".

Textile Institute (joint meeting with the Industrial Group of the Manchester Statistical Society, at 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. E. Lord: "Some Practical Aspects of Sampling with special reference to the Cotton Industry".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. E. G. Cox: "Crystallographic Technique and its Chemical Significance" (Tilden Lecture).

Royal Institute of Chemistry, London and South-Eastern Counties Section (at Medway Technical College, Gillingham), at 7.30 p.m.—Scientific Film Display, followed by Discussion on Local Activities.

Friday, October 24

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Atmospheric Turbulence".*

Chemical Society (joint meeting with the Southampton University College Chemical and Physical Societies, in the Physics Department, University College, Southampton), at 5 p.m.—Prof. C. K. Ingold, F.R.S.: "Isotopes and Molecular Spectra".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Presidential Address.

Sheffield Metallurgical Association (joint meeting with the Royal Institute of Chemistry, at 198 West Street, Sheffield), at 7 p.m.—Dr. H. J. T. Ellingham: "Chemical Metallurgy".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Agricultural Economist in the Department of Agricultural Economics—The Director, Nottingham University College School of Agriculture, Sutton Bonington, Loughborough (October 25).

Scientist (Grade III) with good general graduate scientific training and some experience in physiology or biology, for the London Headquarters of the National Coal Board—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting G.433/47A (October 25).

Assistant Lecturer in Dyeing in the Bradford Technical College —The Director of Education, Town Hall, Bradford (October 25).

Lecturer in Mechanical Engineering—The Principal, Dudley and Staffordshire Technical College, Dudley (October 25).

Senior Assistant in Mechanical Engineering, a Senior Assistant in Metallurgy, a Senior Assistant in Structural Engineering, and a Lecturer in Science, at the Constantine Technical College—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (October 25).

Head of Department of Electrical Engineering, Oldham Municipal Technical College—The Director of Education, Education Offices, Union Street West, Oldham (October 25).

Lecturer in Physiology—The Secretary, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (October 27).

Chemist-in-Charge at the Royal Ordnance Factory, Birtley, Co. Durham, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.810/47A (October 28).

Officers to undertake original investigations with poultry in (*a*) Nutrition, (*b*) Pathology, (*c*) Endocrinology, and (*d*) Animal Behaviour, at the Poultry Research Centre, Edinburgh—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (October 31).

Librarian (temporary) at the Marine Laboratory, Torry, Aberdeen—The Ministry of Labour and National Service, Room 669, York House, Kingsway, London, W.C.2, quoting G.38/47A (October 31).

Director of Design (Ref. C.583/47A) with long experience in chemical plant design; a Director of Design (Ref. C.584/47A) with exceptional organising ability and a first-class experience of mechanical engineering; a Director of Design (Ref. C.585/47A) with an extensive knowledge of the design of heavy civil engineering works and of mechanical plant; and a Director of Engineering Services (Ref. C.586/47A) with an extensive experience in engineering design and preparation of specifications and plans for construction, at the Department of Atomic Energy, Risley, Warrington—The Ministry of Labour and National Service, Technical and Scientific Register, Room 660, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 31).

Principal of the Gloucester Technical College—The Education Officer, Belsize House, Brunswick Square, Gloucester (November 1).

Graduate (M.Sc. or B.Sc. in Chemistry) as Research Assistant to the Leather Research Association, New Zealand Government—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (November 7).

Warden of Malham Tarn Field Centre—The Director, Council for the Promotion of Field Studies, 10 Exhibition Road, London, S.W.7 (November 10).

Lecturers in Physiology, Bacteriology, Biochemistry (2), Dental Prosthetics, Orthodontics and Dental Anatomy, in the King Edward VII College of Medicine, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (November 12).

Senior Scientific Officer at the Royal Air Force Acoustics Laboratory, London—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2017 (November 27).

Director of Fisheries in Hong Kong—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Plant Physiologist by the Research Division of the Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Plant Physiologist'.

Lecturer in the Department of Mathematics—The Principal, Technical College, Huddersfield.

Chemist in the Department of Agriculture in the Colonial Agricultural Service, British Guiana—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Lecturer in Physics at Leeds College of Technology—The Director of Education, Education Department, Leeds 1.

Senior Geologist in Nigeria—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Physicist (male or female) to the Radiotherapy Centre—The Medical Superintendent, St. Luke's Hospital, Guildford, Surrey.

Director of Research—The Chairman of the Council, Coal Tar Research Association, Gas Industry House, 1 Grosvenor Place, London, S.W.1.

Director of Research (physicist)—The Chairman, Federated Foundries, Ltd., 75 Hawthorn Street, Glasgow, N.

Assistant in the Department of Chemistry (with special qualifications in Physical Chemistry)—The Secretary, The University, Aberdeen.

Professors of Pharmacology and Physics, and Assistant Professors of Pharmacology, Pathology and Biology, at the Royal College of Medicine, Baghdad—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18525.

Lecturer in Mathematics principally to Engineering Degree students, a Lecturer in Electrical Engineering to National Certificate and Degree students, and a Lecturer in Mechanical Engineering to National Certificate and Degree students—The Principal, College of Technology and Arts, Eastlands, Rugby.

Demonstrator in the Department of Physics—The Registrar, University College, Singleton Park, Swansea.

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TEACHERS IN TECHNICAL COLLEGES AND SCHOOLS

IN an article in *Nature* of June 22, 1946, the salary scales of teachers in technical schools in Great Britain were criticized in the following terms: "the very comprehensive character of the Burnham scales for technical teachers militates against their effectiveness in the realm of higher technology. The scales for technical teachers have, for reasons which it is not easy to understand, been closely tied to those applicable to teachers in primary and secondary schools. For the large majority of teachers in technical institutions they are in fact identical with them, and only in the provision of separate scales for heads of departments in technical colleges and the introduction of a senior assistant scale for a limited number of technical teachers do they differ from the school salaries. The scales are designed to cover the whole range of further education from the teachers in a small country technical institute to the lecturer in a major technical college, the junior lecturer in which, however advanced and important his work, may be on the same salary scale as the teacher in the smallest institution."

These words are no less applicable to the recently announced proposals of the Burnham Technical Committee which will, if accepted by the constituent bodies, become operative on April 1, 1948. The proposals made by the Technical Committee follow closely those put forward by the main Committee, which is responsible for the recommendations in respect of teachers in primary and secondary schools. They include, for example, the same basic scale, the same proposals regarding the 'London Area', the same provision for graduates, and the same intention to abolish the merger clause. Again, in the provision of posts of special responsibility, local education authorities are left to determine the number of such posts (between 20 per cent and 27½ per cent of the number of full-time teachers other than principals) to whom the Burnham Technical Report applies (which is, admittedly, an improvement on the present position of between 19 per cent and 21 per cent); but the financial limits are, as in the main report, between £50 and £150 per annum for men, and between £40 and £140 per annum for women.

More satisfactory, however, are the proposed scales for senior assistants and heads of departments. In these a real attempt has been made to recognize the validity of the claim—made in the McNair Report on the Training of Teachers—that a senior lecturer in a technical college is responsible for work not dissimilar from that of a lecturer in a university, and that the head of a large department in a technical college has responsibilities for organisation and research comparable with those of a university professor. The proposed salary scale for senior assistants is £700–£25–£800 per annum for men, and £560–£20–£640 per annum for women. For heads of departments, it is proposed that there should be four fixed grades with a maximum in the fourth grade of £1,250 per annum for men and £1,000 per annum for women, and a flexible fifth grade which will allow local education authorities to fix, in agreement with the Minister of Education, a salary beyond these limits for a departmental head in a large college.

Even if these scales are agreed, much must depend on the policy adopted by local education authorities in appointing senior assistants and in grading departmental heads. But the difficulties which local education authorities will encounter—and the variations which must inevitably occur between the practice in one area and another—are not likely to be lessened by the failure of the Burnham Technical Committee to establish salary scales for principals. Since failure to do so in 1945 is an important factor affecting adversely the recruitment of highly qualified men and women possessing suitable training and experience to the staffs of major technical colleges, it is certainly to be hoped that the Minister of Education will interpret generously the provision which empowers him to report to the Committee in 1951 on the review of principals' salaries which local education authorities are required to make in the light of the other recommendations in the report. Since it is not unreasonable to suppose that the recommendations of the Percy Committee regarding the National Council of Technology and the regional advisory councils will, within the next three years, be fully implemented, the time may well be opportune in 1951 for the Minister to consider drastic changes in the administration and finances of technical education in Great Britain.

CHEMICAL BASIS OF MUSCLE CONTRACTION

Chemistry of Muscular Contraction

By A. Szent-Györgyi. Pp. vi+150. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 4.50 dollars.

THIS book is largely a summary of the work of the Szeged school carried out just before or during the war years, and is not designed for the consideration of past or contemporary studies on muscle and muscle proteins. It is, indeed, an intensely individual book, representing a rather novel and daring approach to the problem of physiological contraction. This, no doubt, explains the widespread interest which Prof. Szent-Györgyi has aroused, and among the background of polemical discussion which such interest has invoked, the reviewer must attempt an impartial judgment which is not shocked into scientific conservatism by novelty, but is based solely upon objective consideration of experimental data. Unfortunately, a critique along these lines is not wholly possible: some results are personally communicated; others are derived from data not yet accessible; others, still, do not conform with more recent experiments as described in a 'stop-press' section (Part IV). In these circumstances, it seems most profitable to discuss only the more important features which are especially relevant to the problem of muscle biochemistry, leaving the interpolated section on "The Continuum Theory" (Part III) for other comment.

The outstanding contribution is the discovery that the muscle fibril contains an, as yet, ill-defined protein termed 'actin' which interacts with myosin to give an actomyosin complex. Actomyosin is influenced by traces of adenosinetriphosphate in two different ways, according to the ionic strength of the medium. In 0·5 *M* potassium chloride, the complex exists as a thixotropic gel which is broken up into its component molecules in presence of adenosinetriphosphate; in 0·05 *M* potassium chloride, however, the gel on addition of adenosinetriphosphate exhibits an intense synæresis (termed by Prof. Szent-Györgyi 'contraction'), giving a dense precipitate of actomyosin containing 50 per cent of its weight of protein, whereas myosin precipitates ordinarily contain only 2–4 per cent of protein. It is this latter effect which forms the basis of various speculations on muscle contraction.

It is clear that the actin–myosin interaction is an unusual one, and more recent work in Britain and Denmark has emphasized this fact in the finding that the sulphydryl groups of the myosin partner play an essential part. Obviously, the urgent need, before attempting to relate the actin–myosin–adenosinetriphosphate interrelationships to muscle contraction, is to resolve the mechanism of this synæresis. Does it involve the aggregation of micelles and the squeezing-out of intermicellar water as in the formation of the fibrin clot? Or does it involve an intramolecular saturation of side-chain linkages? There are no really adequate data to decide these facts, and to transpose this system to muscle itself as the basis of the contractile process is not to offer an explanation of how muscle contracts; the clockwork of the model is missing. There might be some virtue in the model if it conformed with accepted concepts of the structure of the fibril; but in the assumption that the contracting elements have a spiral structure, it opposes the evidence of the electron microscope and X-ray diffraction. Moreover, the experiments relating to the energetics of muscle contraction, even if valid, are not specific to the theories advanced and reveal nothing of the molecular mechanism of contraction.

In all that concerns the properties of proteins there are serious misconceptions. The whole treatment of the binding of ions by myosin is both confused and confusing, and governed by physico-chemical inventions which not only conflict with each other but also with experimental fact and with physico-chemical theory. It is assumed, for example, that when a neutral salt is added to a negatively charged myosin precipitate, cations are adsorbed in such a way that the protein becomes isoelectric. The extension of this adsorptive process to the point where the protein dissolves lands the author into great difficulties, as a reading of the section on p. 114 adequately shows. Other claims, that myosin is not a globulin, and that it is genuinely crystalline, are quite inadmissible.

To the biochemist, the enzyme sections present a bewildering display of new facts and conclusions which must certainly invite both interest and criticism. No final judgment can be attempted, since much of the experimental detail is not available. There is a tendency, however, to attribute an astonishing variety of findings to an astonishingly simple system. It is said that myosin–adenosinetriphosphatase, acting in conjunction with 'protein II', effects first a breakdown to adenosinediphosphate; phosphate is then transferred from the pyro- to the amino-group to give a new adenosinediphosphate, which is then simultaneously de-phosphorylated and deaminated. In absence of protein II, myosin–adenosinetriphosphatase is stated to produce not only adenosinediphosphate but also an adenosine-tri- and diphosphate dinucleotide. Obviously, if these reactions occur, a rather complex enzyme system is present. Again, the metal activation of adenosinetriphosphatase gives rise to a complex picture which is more easily accommodated by assuming the presence of other enzymes, and these effects have, in fact, been discussed in contemporaneous studies. There are strong suggestions that some of the reactions induced by proteins I and II are due to Kalckar's myokinase: protein I plus myosin plus adenosinediphosphate produce a synæresis of actomyosin, due to the biosynthesis of adenosinetriphosphate, presumably by the agency of myokinase. Because the partially purified protein I contains a chromoprotein (fluorochrome), it is tacitly assumed that this is the enzyme concerned in the above reaction. These several points serve to implement the contention that the findings must be supported in due course by the most exhaustive experimental evidence. In this connexion, it is necessary to stress that to prove the existence of an isomeric adenosinediphosphate or of a new dinucleotide is a most difficult task; one recalls inevitably the controversies on the structure of adenosinetriphosphate itself, and the careful studies on the nucleotide of heart muscle, claimed by some to be a diadenosine pentaphosphate, by others a mixture of adenosine-tri- and diphosphate, and in any event a problem still unresolved.

These are not the only aspects of the enzymic material which even in the most favourable light must remain contentious; equally so are the conception of 'protins', the implication that succinic dehydrogenase is an actomyosin, and that adenosinetriphosphatase is a property of 'contracted' actomyosin. For the unwary reader, several errors are apparent: the ordinate of Fig. 16; the salt concentration, at the top of p. 28; and the fibre dimensions, p. 32.

Although objective scientific criticism must be unfavourable, and although it is difficult to separate the gems of fact from the trinkets of fancy, so deftly are they intermingled, the book possesses many virtues. It is eminently readable, imaginative, stimulating, sometimes humorous, and reflects Prof. Szent-Györgyi's own delightful and unique personality. Though it may very profitably be read by all critical people, it should not be recommended to uncritical and over-receptive students. In the last analysis, the hard core of the book, the myosin–actin–adenosinetriphosphate interrelationship, holds great possibilities for the future understanding of muscle biochemistry and biophysics.

KENNETH BAILEY

PEONIES

A Study of the Genus Pæonia

By F. C. Stern. Pp. viii + 156 + 15 plates. (London: Royal Horticultural Society, 1946.) 63*s*.

ALL who are interested in the genus *Pæonia*, whether botanists or gardeners, will welcome Colonel Stern's critical review, and the Royal Horticultural Society is to be congratulated in producing such an imposing volume. The author's skill as a horticulturist has earned him a high reputation in the acclimatization of plants, and this talent has been directed during the last twenty-eight years to the cultivation of wild species of peony. With his study of living material, examination of dried specimens in the principal herbaria, and survey of the literature bearing on the genus *Pæonia*, the author is well equipped to present an authoritative account. He freely acknowledges the assistance which he has received from professional botanists in the elucidation of taxonomic and nomenclatural problems.

Chapter 1 contains a conspectus of the genus in which the species are grouped in three sections: *Moutan*—an Asiatic group of four species with woody stems and with prominent development of the disk at the base of the carpels; *Onæpia*—consisting of two herbaceous species, native in western North America, in which the disk is prominently lobed; *Pæon*—a widespread section of thirty-seven species which are herbaceous with no conspicuous lobing of the disk and which extend from south-western Europe to Japan. An interesting feature in the section *Pæon* is the occurrence of eight pairs in which the plants are practically identical, except that in one member of each pair the carpels are glabrous while in the other they are densely pubescent. There is no geographical segregation in each pair, and Colonel Stern regards the distinction as only of varietal status. Four new subsections are defined and typified, and artificial keys are given to the sections, subsections, species and varieties; and it may be mentioned that the keys, tested on fresh and preserved material, have proved a satisfactory guide to the identity of the plants. The morphology of the genus is discussed, and an assessment is made of the characters of systematic value.

In the final section of the first chapter there is an account of the cytology of the genus, and a list is given of the chromosome numbers of the different species as determined at the John Innes Horticultural Institution. It is possible to distinguish cytologically the New World species from those of the Old World, but otherwise the size and morphology of the chromosomes is very uniform. In certain closely allied species, difficult to distinguish on their external morphology, chromosome numbers have been accepted as taxonomic criteria, and in the case of *Pæonia* this policy may be justified. Many systematists, however, will disapprove of the recognition of species based solely on differences in chromosome number and, should similar examples be multiplied, it may be necessary to devise a separate nomenclature for cytological categories.

Chapter 2 contains a summary of the distinguishing characters of peony species and a detailed account of their geographical distribution. The sections are reviewed individually and the distribution of the various groups is shown very clearly on beautifully delineated maps. In discussing the geographical range of the members of the genus, Colonel Stern suggests that the cytology of the species indicates relationships which, when considered in association with the present distribution and comparatively recent climatic history, give a clue to their evolutionary spread. His discussion is certainly suggestive, and his speculations, though applying to a relatively small group of plants, will be carefully weighed by students of plant geography.

The genus is holarctic, with two species in western North America and the others with a wide range across the Old World. The closely related North American species are diploid, and in their botanical characters are most akin to the shrubby Chinese species. In Europe and the outlier in North Africa, groups of allied species and varieties occupy the same geographical area, and in each of these groups one species is diploid with a much more restricted range than the others, which are tetraploid. Excluding the representatives in the Caucasus and Asia Minor, the Asiatic groups of species and varieties (which contain what are probably the most primitive species, including herbaceous members with more than one flower to a stem and also shrubby species) are all diploid, with the exception of one group which has a diploid species in Japan and a connected tetraploid on the Chinese mainland. Why in Asia and America do the diploid species so greatly outnumber the tetraploids, and why do tetraploids predominate in Europe? Colonel Stern suggests that events during and after the glacial period may have determined the cytological constitution of species and so influenced their distributional potential.

In Europe, by the southerly displacement of the vegetational zones during glacial times, the existing diploid peonies were forced into the Mediterranean basin and on to some of the Mediterranean islands. It is supposed that as a result of this geographical disturbance tetraploid species were derived from the diploids and, when conditions ameliorated, the more vigorous and better adapted tetraploids spread rapidly northwards and also crossed into north Africa. This hypothesis may explain why, in the European groups of related species occurring in the same areas, the diploid species have a much more restricted range than the derivative tetraploids. The diploid peonies of eastern Asia, it is surmised, are ancient relicts, which survived *in situ* during the glacial epoch and thus avoided genetic disturbance leading to tetraploidy. Cytological investigation of certain related genera and species may assist in the interpretation of their geographical range; but the genetic factor, while obviously important, must not be emphasized to the exclusion of other considerations. It seems significant that the genera in the British flora notorious for the numbers of 'critical' or endemic species have all been disrupted to some extent in the glacial periods, and the complications in these groups may be due to genetic disturbance resulting from climatic upheavals.

The individual species and varieties are fully described and discussed in Chapter 3; a full synonymy is given and specimens examined are cited. Unfortunately, scant mention is made of the collections, including types, preserved in the British Museum, and this disregard has resulted occasionally in an inadequate appreciation of the geographical range. For example, *P. Delavayi*, according to the monograph, is confined to Yunnan; but there is a specimen (*Kingdon Ward* 12214) from the Po-Yigrong region of south-east Tibet which was named by the author and yet is omitted from his enumeration. A more serious oversight has led to the treatment of Pallas's *P. hybrida* as a species *non satis nota*. Type-material is, however, preserved in the British Museum and, by Colonel Stern's classification, is referable to *P. anomala* var. *intermedia*.

One would have expected, in a book bearing the *imprimatur* of the Royal Horticultural Society, that some attempt would be made to deal with the hosts of named hybrids and forms which are more generally cultivated than the wild species; but for information on these, gardeners must still refer to nurserymen's catalogues. Apart from these criticisms, the enumeration reveals a careful and well-considered survey of the genus.

A fully documented chronological bibliography of the genus occupies Chapter 4, and a history of the species in cultivation with practical advice on their culture concludes the volume. The list of peony species and synonyms forming Appendix 1 gives no references to the text and could have been conveniently included in the general index.

"A Study of the Genus Pæonia" is a credit to the author, artists, printers and publishers, and sets a high standard in botanical and horticultural writing. The book is a splendid and timely token of British scholarship and craftsmanship, and the freshness of the beautiful coloured plates calls for a special word of praise. Perhaps it is not too much to hope that the Society will sponsor further volumes in this style; they could scarcely fail to appeal to botanists and gardeners alike. GEORGE TAYLOR

TECHNICAL MATHEMATICS

Applied Mathematics for Engineers and Physicists
By Dr. Louis A. Pipes. Pp. xiii+618. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 27*s*. 6*d*.

THIS text is an excellent addition to the increasing number of books which seek to acquaint the physicist and engineer with the modern methods of mathematics as applied to technical problems.

The subject-matter is based on lectures given by the author at the Graduate School of Engineering, Harvard University, and covers both basic mathematics and relevant applications to physical and engineering problems such as conduction of heat and vibrations of beams.

Though general in scope, the book should be valuable to the specialist as a work of reference which can be consulted to ascertain the power and field of application of particular methods such as the use of matrices or of the operational calculus. Having chosen a method promising for his particular problem, the research worker can then proceed, if necessary, to a specialist book, references to which are given by Dr. Pipes at the end of each chapter.

On a point of detail, it is noted that two lists of Laplace transforms are given in widely separated chapters, involving considerable duplication, the first list being in excellent tabular form, whereas the second is given in the less easily consulted form of consecutive equations without tabular division. In future editions it is suggested that these lists could be amalgamated into one table at the end of the book for ease of reference. Apart from this minor criticism, the text appears well written and arranged and includes problems for the reader to test his skill or the power of a method.

Though primarily designed for the graduate, this text could well take a place on the bookshelf of the brighter undergraduate, since the subject-matter is unusually wide in range, covering, for example, both a first introduction to complex numbers in the second chapter and the analysis of non-linear oscillatory systems in the final chapter.

In general, this book can be recommended to all engineers and physicists interested in improving the range and power of the mathematical tools at their command. E. N. FOX

A Practical Course in Agricultural Chemistry

For Senior Students of Agriculture, Dairying, Horticulture and Poultry Husbandry. By Frank Knowles and Dr. J. Elphin Watkin. Second edition. Pp. xi+216. (London: Macmillan and Co., Ltd., 1947.) 12*s.* 6*d.* net.

LABORATORY handbooks of agricultural chemistry for students are not numerous, and the second edition of Knowles and Watkin's useful practical course is especially welcome at present, when laboratories and teachers are so hard pressed to cope with their swollen classes.

This book adequately covers the subject, and one feels that it has been written by men of experience who are used to helping students and are well acquainted with their difficulties in laboratory manipulations. While not claiming to be a textbook, this manual includes sufficient background to explain the import of the exercises described.

Since the first edition, in 1936, new commodities, concepts and methods have come into use, and the authors have revised and enlarged their text accordingly. The section on soil has been improved by additional exercises on moisture relationships, nitrogen economy and cation-exchange aspects of the soil, while the recent prominence of triple superphosphate, agricultural salt and sewage sludge is recognized in the fertilizer section. There are new exercises on vitamin C and on blood, and the section dealing with dairy products has been enriched by amplification of the pages on the freezing point of milk and on dairy detergents. The detection of mineral deficiencies in plants by leaf analysis breaks new ground here, and the concluding section on fungicides and insecticides now includes exercises on the newer products such as D.D.T. and 'Gammexane'.

These various additions have expanded the work by twenty-six pages, but its clear type and prominent headings make it easy to use and read.

Microfotografia e Macrofotografia

Principi e applicazioni della technica microfotografia al laboratorio di recherche scientifiche e industriali. Per Prof. Edgardo Baldi. Pp. xii + 349 (18 plates). (Milano: Ulrico Hoepli, 1946.) 900 lire.

THE Italian title of this book may well prove misleading to English readers. Its subject is in the main photomicrography (not microphotography), with a relatively small section dealing with such matters as still photography and document reproduction.

The author is a biologist, and it is therefore not surprising to find that the physics of the microscope is treated from an elementary point of view. Nevertheless the first two chapters cover all that is essential to an understanding of the role of illumination and the formation of images. Brief mention is made of the phase-contrast technique, which is now enjoying such a deserved vogue. The Köhler system of illumination is given justifiable emphasis, and detailed instructions are provided for adjusting the illuminating system. The second chapter concludes with descriptions of the well-known types of condensers and vertical illuminators—these latter including that of Lieberkühn and the Leitz 'Ultropak'.

Chapters 3 and 4 deal with both ordinary and special types of equipment, including objectives and eyepieces. Chapter 5 treats the question of macrophotography, and Chapter 6 that of filters. Chapter 7 gives a general outline of the procedure for taking a photomicrograph, while the final chapter concerns itself with photomicrography in the infra-red and ultra-violet regions respectively.

There are a number of elementary errors in this book. The camera head indicated in Fig. 133, for example, is shown with a semi-reflecting prism of a type which would ensure that no image could possibly be formed on the photographic plate. A great deal of care is called for in the preparation and publication of a handbook of this type, care which in this case one feels has occasionally been lacking. The book contains little information not already available elsewhere, and is consequently not likely to be in great demand outside Italian-speaking countries.

H. H. HOPKINS

Atlas of Histopathology of the Skin

By Prof. G. H. Percival, Prof. A. Murray Drennan and T. C. Dodds. Pp. viii + 494. (Edinburgh: E. and S. Livingstone, Ltd., 1947.) 75*s.* net.

APART from the comprehensive and justly famous "Pathology of the Skin" of Macleod and Muende, British medical literature is lacking in works on this subject. This new book is smaller in scope than the former, the authors confining themselves, not too rigidly, to the commoner skin diseases and restricting description and discussion to an adequate minimum. Details of pathological technique are entirely omitted.

The 376 illustrations are all photomicrographs in colour, and the reproductions, with few exceptions, are most exact at all magnifications. Those dermatologists who have, in the past, decried photographs as less revealing than drawings will do well to study these pictures.

The book is intended to be a companion to textbooks of dermatology and a guide-reference for dermatologists and pathologists. In these aims the authors have been most successful. Special praise is due to Mr. T. C. Dodds, the technician and photographer, and to the printers for the excellence of this publication. It will be welcomed by everyone in the field of dermatology and may stimulate the laggards in this neglected field of investigation.

An Insect Book for the Pocket

By Edmund Sandars. Pp. 350 (36 plates). (London: Oxford University Press, 1946.) 10*s.* 6*d.* net.

THE objects of this little book are to aid its users in identifying and learning something about the larger insects in the British Isles. Owing to the number of species—more than twenty thousand—the size criterion is adopted in order to keep the subject within reasonable compass. Only species exceeding half an inch in body-length, or one inch in wing-span, are dealt with, and, in this way, the number of families to be described is reduced from more than three hundred to about 130. Groups consisting of very small insects only come in for mention if they are of special interest or of economic importance. It is surprising how well this very arbitrary standard has worked out in this manual. It is an accurate and well-written little book. The coloured plates and text-figures are adequate for their purpose and there is a useful list of works for consultation. A pleasing feature running through the pages is the indication (in brackets) of the meanings of the generic and specific names referred to: also the price of the work is very reasonable under present-day conditions.

A. D. I.

PENICILLIN AND OTHER ANTIBIOTICS

THE concentrated research effort on antibiotic substances during the last six or seven years has provided results and new materials of the greatest interest to medical science, to chemistry and to general biology. The relatively recent nature of this work, most of which was undertaken as a direct consequence of the clinical success of penicillin, has obscured to a great extent the fact that work on antibiotics had been carried on since the middle of the nineteenth century, in the fields both of medical microbiology and of plant pathology. The organisers of the symposium on "Penicillin and other Antibiotics" at the British Association meeting at Dundee, by bringing together Sections B (Chemistry), I (Physiology) and K (Botany), sought to arrange their programme so that these various aspects were touched upon.

Sir Alexander Fleming gave a general introduction to the symposium. Defining an antibiotic as "a substance, produced by a living body, which is toxic to micro-organisms", he pointed out that neither the effect nor the word antibiotic is new. Antagonism between bacterial colonies or between mould colonies and bacteria is a commonplace of clinical laboratories, well known for years before the chance contamination which led to the discovery of the effect of penicillin. Even in the nineteenth century an antibiotic preparation from *Pseudomonas pyocyanea* known as pyocyanase was used therapeutically, though with little success. All the chemical antiseptics in use at the time of his work on penicillin were more toxic to leucocytes than they were to bacteria, and penicillin was the first substance encountered which destroyed bacteria without having any appreciable effect on human leucocytes. Penicillin retains prominence in its low toxicity, and this is largely responsible for its great clinical success.

Sir Alexander then briefly surveyed the steps leading from his original observations to the large-scale production of pure crystalline penicillin. In the course of this he commented on the highly valuable free interchange of results between academic workers and industrial firms both in Great Britain and the United States, which was in large measure responsible for the rapid progress made during war-time, and regretted that now, in conditions of peace, such co-operation appeared to be much less easily attained. He concluded by remarking that though penicillin has its disadvantages, such as instability in aqueous solution and a definitely limited range of organisms against which it is clinically effective, it is nevertheless not going to be easy to find a drug superior to penicillin in its own field.

Dr. E. Chain dealt with the chemical structure and biological activity of four types of antibiotic. His first type was the polypeptide group comprising gramicidin, tyrocidine and gramicidin *S*. Each of these substances is a simple polypeptide, the proportions of the constituent amino-acids being known in each case. A point of chemical and biological interest is that each of these contains amino-acids of the 'unnatural' *d*-configuration. Gramicidin *S* is chemically the simplest of these substances. The basic unit is a pentapeptide containing the following arrangement of amino-acids:

α-*l*-valyl-*l*-ornithyl-*l*-leucyl-*d*-phenylalanyl-*l*-prolyl.

The gramicidin *S* molecule is probably built up of two of these pentapeptides, linked in a cyclic structure. These substances are both bacteriostatic and bactericidal, active mainly against Gram-positive bacteria. They are not efficient chemotherapeutic agents owing to too great a toxicity. Their high toxicity represents an interesting biochemical problem, as there is no obvious reason why a dekapeptide of the above constitution containing simple amino-acids, each of which is known to be non-toxic, should show such marked pharmacological properties. Subtilin, bacitracin and the colicines, also polypeptide antibiotics of bacterial origin, are remarkable for their high specificity. Further knowledge of their chemical structure would be of great interest, as it might lead to an understanding of the relation between the structural arrangement of the polypeptide molecule and its specific biological activity.

Helvolic acid is probably a polycyclic compound related to the triterpenes. It is highly active against Gram-positive bacteria, relatively non-toxic to mice and antibacterially active in the body. Nevertheless, it is not an effective chemotherapeutic agent in mice. Analysis of its mode of action has shown that it is purely bacteriostatic, having virtually no killing effect. The mouse has no natural resistance against *Streptococcus*, and hence helvolic acid, as it does not kill organisms, is ineffective in eradicating a streptococcal infection.

Dr. Chain next considered the only two antibiotics which have shown any practical possibility in medicine, namely, streptomycin and penicillin. Streptomycin is bacteriostatic to some organisms and bactericidal to others. It is of highest efficacy as a chemotherapeutic agent in diseases caused by those organisms which it is able to kill, such as *Hæmophilus influenzæ* and *Pasteurella tularensis*. Clinically, successes have been obtained in the streptomycin treatment of some cases of miliary tuberculosis and tubercular meningitis, but it is yet too early to evaluate finally its role as a chemotherapeutic agent in clinical tuberculosis. Streptomycin possesses certain disadvantages. Like other antibacterial bases, it is most active above *p*H 7, its activity decreasing with decreasing *p*H, and so has relatively low activity at the *p*H of many body tissues. In addition, it is not devoid of toxic effects. More important is the fact that many organisms (including *Mycobacterium tuberculosis*) develop resistance very rapidly, frequently in one or two subcultures only. However, in spite of these objections, streptomycin shows considerable promise as a chemotherapeutic agent in several diseases where penicillin is ineffective.

In dealing with penicillin, Dr. Chain pointed out the chemical novelty of the β-lactam ring in the penicillin molecule. This is responsible both for the instability that caused the initial difficulties in isolation, and for the extraordinary molecular rearrangements that can be produced by relatively mild chemical treatments. From the medical point of view, penicillin still remains unique among all antibacterial substances in that it is non-toxic, not antagonized by tissue constituents, is independent of inoculum-size and has a definite killing effect on rapidly dividing cells. With the exception of *Staphylococcus*, bacteria do not readily develop penicillin resistance.

Here the discussion was continued by Dr. J. A. Elvidge, who described work on the chemical synthesis of penicillin, with particular reference to the more recent work carried out at the Imperial College of

Science and Technology, London. Indications of successful syntheses of traces of penicillin were obtained in Oxford and in the United States in 1944, and the isolation of minute quantities of penicillin was reported by du Vigneaud in 1946. The surprising fact is that these syntheses were achieved by methods based on a mistaken view of the structure of the penicillin molecule. For a considerable time chemical evidence was unable to decide whether the now well-known thiazolidine-oxazolone or β-lactam structure was correct; a decision in favour of the latter was based on data provided by X-ray crystallography and infra-red absorption spectra. The syntheses mentioned above were based on the supposed thiazolidine-oxazolone structure; that of du Vigneaud being by the condensation of 4-methoxymethylene-2-benzyl oxazolone with penicillamine. However, only traces of penicillin have been produced by this method, which appears to be of little practical value, and consequently at the Imperial College routes of a more promising aspect were sought and eventually found in methods involving thiazoline intermediates. The present state of this work was then described in some detail by Dr. Elvidge, and it was evident that further results of great interest are to be expected.

A really workable synthesis of penicillins and structurally related compounds is highly desirable. Pentenyl-, benzyl-, p-hydroxybenzyl- and heptyl-penicillin have been found naturally. Even among this relatively small number of penicillins, quite marked differences in antibacterial activity, solubility and stability are found. Particularly in therapeutic effectiveness do p-hydroxybenzyl- and heptyl-penicillins differ. Hence it is possible that even more effective penicillins could exist, with more desirable physical properties—perhaps enhanced chemical stability and activity against a greater or different range of micro-organisms. Chemical methods of synthesis would make feasible the preparation of many modifications and derivatives and enable the many attractive possibilities to be investigated.

Up to this point, the discussion had centred around antibacterial antibiotics of medical interest. Another approach was made by Dr. P. W. Brian, who spoke on fungistatic antibiotics, considering the matter particularly from the point of view of the plant pathologist. A number of most important plant diseases are caused by soil-inhabiting fungi which attack the roots, vascular systems and base of the host plants. It was found early in the investigation of these diseases that if the host plant were grown in sterile soil inoculated with the pathogenic fungus, the symptoms observed were usually far more severe than if a normal untreated soil were used. It was widely deduced from this observation that some of the normal saprophytic members of the soil microflora are 'antagonistic' to the pathogen, and many such antagonistic organisms were in due course isolated.

Later workers found that in many cases treatment of an infected soil with a culture fluid on which the antagonistic organism had grown was as effective as inoculating the soil with the organism itself. A particularly well worked out research on these lines was that of Weindling (1931–41) on the role of the fungus *Trichoderma viride* in antagonizing the damping-off disease of *Citrus* seedlings caused by the fungus *Rhizoctonia solani*. He found that the disease could be much reduced by acidifying the soil. This was effective, not by directly reducing the vigour of the *Rhizoctonia*, but by encouraging the growth of an antagonistic fungus, namely, *Trichoderma*. He also found that the antagonistic *Trichoderma* could kill *Rhizoctonia* at a distance in an agar medium and that a liquid culture medium on which *Trichoderma* had grown was highly toxic to *Rhizoctonia* hyphæ. He carried this research a stage further and in 1936 isolated in pure form from such toxic culture filtrates the now well-known antibiotic gliotoxin.

Since then, many examples of the production by fungi of substances toxic to other fungi have been discovered, as well as production of such substances by other types of micro-organisms. Some of them are general poisons, toxic also to bacteria and other organisms, examples being gliotoxin, patulin, aspergillic acid, citrinin, gladiolic acid and penicillic acid. Others, such as viridin and glutinosin, are specifically toxic to fungi only. Other substances again, unlike those just mentioned, which have a definite killing effect like most synthetic fungicides, reduce the rate of fungal growth by causing marked abnormality in development; an example is griseofulvin ('curling factor'). [See also p. 574.]

Dr. Brian concluded by suggesting that antibiotics should receive more attention from the point of view of soil processes and soil-borne plant diseases than they have so far done, and that in this field many of those antibiotics which have received little attention from the medical microbiologists, owing to such undesirable properties as toxicity, may nevertheless be of the greatest significance.

The remaining two papers aimed at relating the production of antibiotics by micro-organisms to their general biological and biochemical background, Dr. J. Ramsbottom dealing with the biological, and Dr. S. E. Michael with the biochemical, aspect.

Dr. Ramsbottom confined himself mainly to consideration of production of antibiotics by fungi, but the conclusions he reached may be regarded as equally valid for all antibiotic-producing organisms. The production of antibiotic substances is part of the general problem of the relation between organisms. Organisms do not live in pure culture in Nature, but in the presence of many other kinds of organisms. All sorts of relationship may be possible between different species in a mixed population, from antibiosis to symbiosis. He recalled the original definition of antibiosis by Vuillemin, in 1889, who considered that all types of association could be placed on a scale ranging from the pure parasitism of the blight fungus (*Phytophthora infestans*) on the potato (a phenomenon he called 'antibiose'), where only one partner in the association gained any advantage, the other suffering a corresponding disadvantage, to those cases where, by mutual benefits, both partners gained, such as the relationship between fungus and alga in the lichen thallus ('symbiose'). Marshall Ward expounded similar views at the Dover meeting of the British Association in 1899. More precise definitions of the terms 'antibiosis' and 'antibiotic' than the current ones are needed, or we shall have the same confused thinking that has been associated with symbiosis, which was originally thought best exemplified by parasitism.

More recent research has shown that many of the symbiotic types of association have a chemical basis. For example, it has been found that the well-known observation that infection of orchid seeds with a mycorrhizal fungus is necessary before germination can take place is due to a need of the embryo for aneurin, which is synthesized by the fungus. Similarly, it has been found that on a vitamin-free medium neither the fungus *Mucor ramannianus* nor the yeast *Rhodotorula rubra* will grow at all. If mixed inocula are used, both organisms grow perfectly. The reason for this surprising result is that the *Mucor* is unable to synthesize the pyrimidine moiety of aneurin but is able to synthesize the thiazole moiety, whereas *Rhodotorula* is able to synthesize the pyrimidine but not the thiazole. Thus the two in association act in a complementary manner and growth becomes possible.

In view of many such instances of a chemical background for symbiotic relations, it seems possible that the production of antibiotic substances may have some significance in explaining 'antibiotic relations', whether of the nature of the parasitism of fungi on higher plants or antagonism between fungi and other micro-organisms. Various plant juices have proved to be 'antibiotic'. Fragments of an orchid tuber suppress the growth of its mycorrhizal fungus; this may be related to the fact that the fungus is always restricted to definite areas of the growing root. These facts lead to the tentative suggestion that antibiosis may on occasion be an essential ingredient of symbiosis. Dr. Ramsbottom quoted the antagonism between *Trichoderma viride* and other fungi, with its possible connexion with gliotoxin and viridin production; the antagonism demonstrated by Van Luijk in 1939 between *Penicillium expansum* and *Pythium* spp. and its possible connexion with patulin production; the relation between the wilt-fungus *Fusarium lycopersici* and the tomato plant, in connexion with production of the wilt-producing polypeptide lycomarasmin. Caution is necessary in interpreting these facts; in Dr. Ramsbottom's words "the balance [between organisms] is probably controlled *to some extent* by the ability of some organisms to produce antibiotics, though it would be teleological to suppose that they have a purposeful origin".

Dr. S. E. Michael wound up the discussion by considering the chemical structure of mould antibiotics in relation to the general metabolic chemistry of fungi. Systematic study of the metabolism of lower fungi by Raistrick and his colleagues has shown that moulds of one or of several species yield products which are closely related variants of a particular type of structure. Examples that can be quoted are the toluquinone series (fumigatin and spinulosin); the anthraquinone series of mould pigments (helminthosporin, cynodontin, ω-hydroxyemodin, catenarin and erythroglaucin); the tetronic acid series (carolic acid, dehydrocarolic acid, ascorbic acid and penicillic acid). These few examples—far from complete—show the remarkable variety of compounds found as metabolic products of moulds, and the tendency for these products to be variants of a smaller number of basic patterns of molecular structure.

A number of well-known antibiotics fall into one or other of these general classes. Those of the tetronic acid series are particularly interesting. Tetronic acid belongs to the important and widely distributed class of unsaturated γ-lactones. This unsaturated lactone structure has been found in a number of antibiotic substances, and it is of considerable interest to see how variations on this basic molecular structure affect biological activity. The whole carolic acid series and ascorbic acid are devoid of antibiotic activity. On the other hand, the antibiotics penicillic acid, patulin, vulpinic acid and protoanemonin (extracted from higher plants) are all unsaturated γ-lactones. If their structure is considered, it appears that activity is associated with an unsaturated lactone ring carrying at least one ethylenic or carbonyl radical outside the ring, and also in some cases a methoxy or other ether group attached to the unsaturated carbon atom of the ring. Where the unsaturated radical outside the ring is missing (dihydropenicillic acid, α-β-angelicalactone), or where the ether group has been replaced by a hydroxy-group (the carolic acid series), antibiotic activity is reduced or absent.

These examples show that many mould antibiotics can be recognized as variants or derivatives of structurally known metabolic products. Others, on the other hand, such as penicillin, appear at our present state of knowledge to possess chemical structures not hitherto recognized in natural products.

The wide field covered by this discussion makes it difficult for either a chemist or a biologist to appreciate the significance of all the points brought forward. Nevertheless, it is hoped that this short review will help to indicate the varied types of interest in antibiotics now being shown in different branches of science. It should also be explained that, in order to give a logical presentation of the material, the order in which the various contributions were given has been altered. P. W. Brian

CRACK DETECTION

A TWO-DAY symposium on methods of crack detection was held under the auspices of the Industrial Radiology Group of the Institute of Physics during July 18–19 in the lecture theatre of the Electric Lamp Manufacturers' Association, Savoy Hill, London.

The chairman, Mr. W. J. Wiltshire, explained that the group has recently included lectures comparing other methods of non-destructive testing with radiological methods, and the symposium was an instance of this extension of activity.

A short address was given by Dr. W. Betteridge, who explained the importance of cracks in both metallic and non-metallic components, the various means by which the main types of crack are formed, and the principal methods of detection. The latter he divided into three groups: the essentially visual methods, including the ways of making a crack more apparent, such as etching, dyeing, magnetic ink indication, etc., and radiography, the visual examination then being made on the film instead of on the actual component; the inferential methods such as the use of supersonics or of electrical resistivity, in which the presence of a crack is deduced from its disturbance of the normal lines of sound or current flow; and the mechanical methods, including proof loading, pressure testing, damping, etc.

Mr. C. Croxson dealt in detail with the application of radiography to the detection of cracks. He said that not many years ago a high-grade component containing a crack would have been immediately condemned; but nowadays repairs by excision and welding under radiographic supervision are often satisfactorily performed. A discouraging factor is the difficulty of assessing the mechanical significance of a crack by correlating radiographic results with practical experience. Penumbral unsharpness, due either to a broad focus tube or a small target-specimen distance, is not very detrimental and, within limits, may even lead to increased sensitivity; but graininess in the film is a great handicap, and the use of the finest grained film is recommended. The sensitivity of radiographic methods is higher than generally supposed, and cracks only a few ten-thousandths of an inch in width can be detected in steel plates up to half an inch in thickness if favourably oriented. The discernibility of a crack is related to the ratio of the width to the angle of inclination to the X-ray beam; but for shallow cracks, where the inclination does not noticeably change the appearance of the image, it depends on the cross-section of the crack. Mr. Croxson concluded with a number of illustrations of the application of radiography to the detection of cracks in castings, forgings and welds, and, in summarizing the usefulness of the method, said that, in his opinion, serious hot tears or cold cracks in castings could not escape detection by radiography, and the same applied to cracks in forgings provided a critical technique was used with an understanding of the probable location and direction of the cracks. In welds small cracks could escape detection, but these are usually of little practical significance.

Mr. P. Rowbotham surveyed the various visual, etching and magnetic methods of detection, and explained that for all these the best results could only be expected if the inspectors worked under optimum conditions of lighting. A trained inspector working under ideal conditions can achieve very high sensitivity. Magnifying lenses and low-power microscopes can be helpful, but the small field of view and the necessity for frequent refocusing are disadvantages. Their value is mainly in the assessment of a crack following its detection by a more sensitive method. Brief descriptions were given of several common methods of increasing the visibility of a crack, including etching, anodizing, the use of oil and chalk, fluorescent liquids, etc., all these depending on the absorption into the crack of a liquid which afterwards oozes out. Finally, the magnetic methods for ferromagnetic materials, in which the escape of flux at the crack is indicated by a detector fluid, were described. For all these methods the crack must break through the surface of the part, except that the magnetic method will reveal cracks which are only a small distance beneath the surface.

The use of electrical conductivity methods for non-magnetic metals was dealt with by Mr. A. M. Armour, who explained that while a crack will disturb the lines of current flow in a metal in the same way as the lines of magnetic force in a ferromagnetic material, the electrical method is much less sensitive than the magnetic method because of the lack of a sufficiently sensitive detector of the lines of current flow. Most success has been achieved by the use of scanning search coils coupled to an indicator to give a signal on passing the vicinity of a defect. The use of two balanced search coils symmetrically placed with respect to a primary coil has enabled relatively uniform material such as sheet or bar to be examined successfully; but the method fails when a complicated component is to be dealt with because of the disturbances introduced by changes of section. Success has also been obtained in the search for diametrical cracks in large light-alloy billets by rotating the billet in a magnetic field and causing the eddy currents produced to react on two opposed search coils. A direct-current potential drop method has also proved of value for the detection of laminations in sheet, lack of adhesion in bearing liners, etc.

Supersonic methods were described by Mr. D. O. Sproule. The shadow detection method, in which the effect of a defect on the transmitted primary beam is observed, was considered to be of low sensitivity compared with echo methods, and the method in which the reflected beam interferes with the frequency-modulated primary beam was also described as of less importance than the echo method using pulse excitation. In the latter case the primary beam consists of pulses of sound at a frequency of a few megacycles per second produced by an oscillating quartz crystal, and the reflected energy is picked up by a similar crystal in the intervals between the primary pulses. The depth of the defect is determined by the time interval between the primary and reflected pulses; but the character of the defect producing the echo is not readily determined, although, by frequency variation, defects of relatively large areas, such as cracks, can be differentiated from fine porosity. The application of the method to components of different shapes was described, and the sensitivity to such small defects as hair-line cracks in large steel billets was illustrated.

The last paper was by Mr. M. Baimler, who described the development of industrial radiology in Czechoslovakia. The general position is very similar to that in Great Britain; but the advantage of using a long anode tube, which radiates in all directions in one plane and thus enables a circle of a large number of components to be radiographed at a single exposure, was stressed; the tube-film distance of about 12 feet gives sharp definition, and the increased exposure time is more than compensated for by the number of components dealt with at one time. An ingenious screening stand for dealing with castings weighing up to about 3 cwt. was described.

In the discussion which followed, Mr. A. G. Warren made a plea for the use of the term ultrasonic to describe high-frequency sound, supersonic being used in connexion with speeds above that of sound. The need for a detector for electrical conductivity methods was met in the case of high-frequency currents by sparking across the crack, which was easily visible. He said that cracks at angles above 45° to the direction of the lines of force could easily be detected by the magnetic ink method if the flux density were high enough. Mr. Rowbotham agreed, but found it preferable to control the flux density so that the limit of sensitivity was at about 45°. Mr. Armour described a combined radiographic and magnetic method, the exposed and processed film forming the base on which the magnetic record is deposited by a special detector ink. Mr. H. Capper said that fatigue cracks are frequently missed by radiography, and complementary methods should always be applied. Permanent magnets are found useful for magnetic crack detection. Eddy current methods have been found by Mr. E. G. Stanford to be of value for checking consistency of products for dimensions, composition, temper, etc., and the changes introduced by such variables make crack detection ambiguous. Mr. D. J. Jones described the difficulty of finding longitudinal cracks in sealing wires for the lamp industry; visual examination at a magnification of 10–20 was found best. Mr. W. C. Heselwood had found the shadow ultrasonic method preferable to the potential drop method for the detection of laminations in steel plate. In answer to a question by Mr. A. Maskery on the possibility of using a single exploring head for ultrasonic work, Mr. Sproule described a method of using two balanced heads, one on a standard sample and the second exploring the test sample, defects then being indicated by a disturbance of the balance; but he thought that a single head generally gave less information than the separate transmitter and detector.

THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

By Dr. J. M. STAGG

General Secretary

LIKE all large families, the group of scientific unions with the International Council of Scientific Unions as foster mother has a wide range of interests: one of the elder members of the family, the International Union of Geodesy and Geophysics, is itself big enough and broad enough in outlook to find a place for sciences with superficially so little in common as geodesy and hydrology, seismology and oceanography, vulcanology and meteorology, terrestrial magnetism and atmospheric electricity. So the International Union of Geodesy and Geophysics is a real confederation of unions (or associations, as they are called in the Union), each more or less autonomous, having its own president, secretary and bureau, its own statutes and by-laws and its own procedure for dealing with the problems within its domain. In addition, there is a Commission on Continental and Oceanic Structure which has the status of an association, and, more recently formed, a primary Committee on the Social Value of the Earth Sciences to look after the broader economic, social and political implications of the Union's work. Most of the associations have a number of sections or committees specializing in various aspects of their fields of geophysics.

Though all these constituent organisations of the International Union of Geodesy and Geophysics meet at the time of the triennial general assembly of the Union, they also continue their scientific activities for the most part separately, and arrange their own meetings between assemblies as they choose. Little of this has been possible since the general assembly held in Washington in September, 1939; and yet, as the recently published report* shows, it is remarkable how quickly the Union has revived and put its house in order ready to renew its wide activities. There is little doubt that much of this quick recovery is due to the energetic and experienced work of the late general secretary, Brigadier H. St. J. L. Winterbotham. Even before the War had properly begun he had taken steps to safeguard the Union's funds and contrived to keep an emergency organisation running until the end of hostilities, although the president, Dr. la Cour, had died early in the War and contacts with other senior officers were very restricted. Some of the associations, on their side, continued their work in some measure throughout the War, supporting themselves on the annual subscriptions from their own and neighbouring countries.

As a sequel to a meeting of the Executive Committee of the Union, convened shortly after the end of hostilities, an extraordinary assembly was called in 1946 to put the Union on its post-war feet again. That assembly was held in Cambridge in 1946 and was attended by delegates from sixteen of the pre-war total of some thirty member countries. It made important decisions for the future of the Union, not the least being a radical change in the method of subscription by member countries and institutions. As with most other similar Unions, countries adhering to the International Union of Geodesy and Geophysics have paid (or tried to pay) an annual subscription determined by their population. This was manifestly unfair to countries like India and China, and had obvious results. A decision of last year's extraordinary assembly was designed to provide a remedy: in future each member country may itself choose any one of eight categories of membership, the only proviso being that the category selected has to be formally approved by the Union's council, on which every country has one representative. The category of membership determines the annual subscription to be paid, and the voting power in Council or General Assembly in discussions involving finance.

The details of this innovation have been embodied in new statutes and by-laws which were adopted by the Cambridge assembly and have since been approved by all adhering countries. These new statutes and an account of the other decisions made by the extraordinary assembly are published in the 1946 report: the report also includes brief summaries of the activities of the various associations since the Washington meeting, a list of the officers of the Union and its component organisations, and the text of an agreement recently made between the International Union of Geodesy and Geophysics (as one of the family of the International Council of Scientific Unions) and U.N.E.S.C.O. By this agreement the International Union will play its part in disseminating information on geodetic and geophysical subjects in countries where contacts on cultural and scientific matters have hitherto been few: and in return, U.N.E.S.C.O. will use its good offices to promote these contacts by financial support for publications and meetings. U.N.E.S.C.O. has already allocated grants from its 1947 budget for this purpose.

U.N.E.S.C.O. will also help in another field of the International Union's activity. Real progress in geodetic and geophysical subjects requires the closest possible international collaboration on a long-term basis. Sound theories concerning isostasy, or the figure of the earth, concerning the nature of the internal structure of the earth as revealed by earthquakes, or the form of the earth's magnetic and electrical fields, or, again, concerning ocean currents or the circulation of the atmosphere, cannot be achieved in a year or two. In each of these fields of investigation there is a great need for a central bureau, maintained on a more or less permanent basis, where at least all the main facts can be collected and made available to those specialists, wherever they be, who are capable of studying them. Since its formation in 1919 the International Union of Geodesy and Geophysics has become responsible, sometimes with other interested unions or institutions, for maintaining several such permanent or quasi-permanent services: the International Seismological Summary, the Isostatic Institute in Helsinki, the International Latitude Service, and the Bureau International de l'Heure are examples. The maintenance of these services, with their staffs and publications, has become a continuous drain on the funds of such unions as the International Union of Geodesy and Geophysics, even to the detriment of other investigations which equally require international co-operation though on a shorter term basis. Following on the U.N.E.S.C.O. agreement, it is therefore a good omen for future development in geodetic and geophysical science that U.N.E.S.C.O. will try to allocate grants for these bureaux and so relieve the International Union to engage in the many other important problems which await investigation.

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* International Union of Geodesy and Geophysics. Report for the War Years 1939–45, with the proceedings of the Executive Committee of the Union, Oxford, December 1945, and the Extraordinary Assembly, Cambridge, July 1946. Published by the Bureau of the Union at Kew Observatory, Richmond, Surrey.

With the example set by the parent union at its 1946 assembly, many of the International Union's associations have had meetings of their own executive committees and councils to put their post-war houses in order and to make plans for the next general assembly, which will be held in Oslo during August 19–28, 1948. Partly in anticipation of that assembly and partly to renew and extend interest in the work of the Union, a pamphlet describing its organisation and scientific activities and those of its constituent associations and commissions has just been published by the Union's Bureau (at present at Kew Observatory, Richmond, Surrey), where copies can be obtained.

THE SWEDISH DEEP-SEA EXPEDITION

By Prof. HANS PETTERSSON

THE Swedish Deep-Sea Expedition left Göteborg on July 4 on board the 1,400-ton motor-schooner *Albatross*, which had been specially fitted out for the purpose at the Lindholmen shipyard with air-conditioned laboratories and accommodation for the scientific staff, dark rooms, workshops, cold-storage room, electric winches, etc. The main purpose of the cruise, which is expected to last for fifteen months, is to investigate the deep ocean bed and its deposits by means of new methods developed in Sweden during the war years. The first part of the cruise, between Madeira and Panama, has now been completed. Some of the results are here briefly summarized.

A new and powerful echo-sounding equipment has been constructed for the *Albatross* by the Marine Instruments, Ltd., of London (formerly Henry Hughes and Sons, Ltd.), in order to get detailed and continuous records of the depth down to at least 7,500 metres. The records so far obtained go down to more than 6,000 metres and are very interesting. They prove that older views of the deep-sea bottom as a smooth, perfectly level surface, especially in the depressions, are radically wrong, at least as regards the part of the Atlantic Ocean which has been traversed. Such surfaces extending over several miles of our course were comparatively rare. Instead, the depth curve moves incessantly up or down, generally by gentle undulations but quite often rising or falling by distinct steps, 100 to more than 300 metres high and from less than one nautical mile to a few miles broad. The change in depth is sometimes so abrupt that the recorder cannot follow it, thus indicating nearly perpendicular walls hundreds of metres in height. One gets the impression of fault lines stretching more or less obliquely across the course. In other cases the slope is steadier, rising or falling by as much as 1 : 10, or even steeper. In certain places where the record tends to become confused, the bottom appears to be covered with small hills or hummocks, the record showing three or more convex lines, partly overlapping or intersecting at one point.

Crossing the central Atlantic Ridge, where the bottom was pronouncedly uneven and rich in steps or hummocks, its highest point found by us, quite close to the place where the Admiralty chart has the depth of 934 fathoms, in lat. 23° 10′ N., long. 45° 10′ W., has a minimum depth of only 786 fathoms or about 1,440 metres. Evidently a close net of echograms will be required for any detailed study of the morphology of the Atlantic bottom.

In the Caribbean Sea the depth curve along our course from Martinique to Panama was much steadier than in the open Atlantic, hummocks and steps in the curve were rare, and the depth remained constant to within a few fathoms over distances of 50–100 nautical miles or even more. It is interesting to note that bottom features similar to those of the Caribbean were found also between Algiers and the Tyrrhenian Sea by the Swedish Expedition to the Western Mediterranean on board the *Skagerak* in 1946.

This surprising unevenness of the deep Atlantic bottom proved a serious complication in our attempts to measure the thickness of the sediment carpet by the method developed by Prof. W. Weibull of Bofors, who accompanied the Expedition to Panama. By means of depth charges detonating at depths of 500, 2,500 or 4,500 metres below the surface, echoes are set up from the bottom itself as well as from reflecting surfaces deeper down in, or below, the sediment. Hydrophones of special construction suspended from the ship convert the sound-waves into electric impulses which are recorded on an oscillograph. Where the bottom profile is rough, diffuse reflexions obscure the oscillograms, whereas over a smooth bottom 'deep echoes' may be recorded. The values found (uncorrected for the somewhat higher velocity of sound in the sediment than in water) vary in the open Atlantic between 300 and nearly 2,500 metres.

In the Caribbean Sea, with its much smoother bottom, the oscillograms are very clear and give values which increase from east to west, from 250 metres to a maximum of 900 metres. The total depth of the reflecting surface, presumably the rocky floor beneath the sediment carpet, thus varies between 4,800 and 7,800 metres in the Atlantic and between 2,900 and 5,600 metres in the Caribbean Sea. In the western Mediterranean the maximum depth of a reflecting surface found in 1946 right in the centre of the Tyrrhenian Sea was 2,600 metres at a water depth of 3,600 metres. It will be of interest to continue these measurements also in the central Pacific Ocean, where we intend also to use depth charges exploding in the sediment itself.

Dr. B. Kullenberg, by means of his piston core-sampler, has taken some dozen cores from depths between 4,000 and 5,600 metres, most of them 10–15 metres long. Some of those taken in the open Atlantic in depths of 5,000 metres or more consist of red clay, which becomes very compact and takes on a deep chocolate-brown colour in the lower levels. Occasionally layers rich in Foraminifera are found intercalated in the red clay. Assuming the latter sediment to increase in thickness by 8 mm. in 1,000 years in the Atlantic Ocean, the lower strata of a core 15 metres long should have been deposited nearly two million years ago, or before the end of the Tertiary Age, when the deep ocean water is generally assumed to have been considerably warmer than during the Quaternary Age. This would seem to make it difficult to uphold an opinion prevalent among oceanographers, namely, that the lime-dissolving effect of the ice-cold Antarctic bottom current is the main or only agency capable of converting calcareous ooze into red clay.

In a 15-metre long core taken from a depth of nearly 4,900 metres at the centre of the Caribbean

Sea, the sediment has a strong greenish hue and displays an interesting stratification, with layers alternately rich and poor in calcareous shells. Dr. Fred Phleger, of the Woods Hole Oceanographic Institution, who was the guest of the Expedition between Martinique and Panama, sampled this core for Foraminifera and also collected plankton from the uppermost 1,000 metres of water by means of tow-nets of special construction.

Hydrographic soundings with temperature observations, also by means of the bathythermograph, and with water samples for chlorine and oxygen determinations were made across the Caribbean. Large-volume samples were taken from various depths, both in the open Atlantic and in the Caribbean, for measurements of uranium and radium. Such measurements have become of especial importance owing to the light they may shed on the ionium precipitation in the sea, which is supposed to be responsible for most of the radium present in deep-sea deposits.

The cores hitherto taken by the Expedition are being sent back to Sweden for analyses by various specialists. The *Albatross* now leaves for the Pacific part of the cruise, with the Galapagos Islands as the nearest goal.

OBITUARIES

Dr. S. H. Daukes, O.B.E.

By the death of Sidney Herbert Daukes, the medical profession has lost its leading authority on the modern medical museum. Daukes died on September 3 after a short illness. The son of the Rev. S. Whitfield Daukes, vicar of Holy Trinity, Beckenham, he was born on April 20, 1879. He was educated at Lancing College where he distinguished himself in various sports, and at Caius College, Cambridge. He took a second class in the Natural Science Tripos in 1900 and then studied medicine at the London Hospital. He qualified M.R.C.S., L.R.C.P. in 1905 and in the same year graduated M.B., B.Ch., Cambridge. After several years spent in hospital appointments and in general practice, he took his D.P.H. in 1912 and in 1913 the D.T.M. & H. By the outbreak of the First World War he had held a post as assistant school medical officer at Leeds and was chief assistant school medical officer for Norfolk.

In the War, Daukes served first as a special divisional sanitary officer in France. In the winter of 1917–18 the War Office established the School of Army Hygiene at Leeds, and Daukes was made responsible for its organisation and administration. He was mentioned in dispatches and received the O.B.E. in 1920. He wrote "A Manual of Sanitation Applied to Military Life", and he contributed the chapters on hygiene to the official medical history of the War.

After the War, Col. Andrew Balfour—later Sir Andrew Balfour—who was director of the Wellcome Bureau of Scientific Research, invited Daukes to become curator of the Museum of Tropical Medicine which had been established by Sir Henry Wellcome. Under Daukes' guidance its scope expanded, and in 1926 it became the Wellcome Museum of Medical Science, with Daukes as its first director.

Daukes held very strong views on the importance of visual education, and he organised his museum with this end in view. Each disease was dealt with as an entity, and in the bays devoted to it, the student could follow out the latest views on etiology, pathology, clinical features, treatment and prevention, each branch being illustrated by photographs, charts, pathological specimens, paintings and other visual representation which was calculated to impress the point in question on his mind. The Museum became an important teaching unit, and it was visited by many medical men from overseas, by practitioners proposing to specialize in tropical medicine, by medical students and by nurses and health visitors. In the years immediately preceding the Second World War, approximately 10,000 persons visited the Museum annually. The Ministry of Health included a demonstration of tropical diseases in the Wembley Exhibition in 1924, and this was largely planned by Daukes acting as organising secretary of the appropriate committee. Similar exhibits were sent to the Wembley Exhibition in 1925, to Antwerp in 1929 and to Paris in 1931. In 1928 Daukes graduated M.D. at Cambridge with a thesis on the medical museum. This thesis was later expanded and published as an important monograph. In 1940 Daukes was asked to take over, as a temporary measure, the administration of the Wellcome Historical Museum, the directorship of which had been held by Sir Henry Wellcome himself until his death.

Daukes was well known, under his pen name "Sidney Fairway", as a novelist with a wide popular appeal. His novels generally dealt with some aspect of medical life, his best known being "The Doctor's Defence" and "The Cuckoo in Harley Street". His last novel, "He Loved Freedom", was published a week or so before his death. His reminiscences will be published shortly with the title "A Pillar of Salt".

He married Emma, daughter of William Kempsell of Reigate, who died in 1944. In 1945, he married Ethel Maud, widow of E. J. T. Hoyle of Doncaster. He is survived by his widow and a son by the first marriage, Lieut.-Colonel Whitfield Daukes, R.A.M.C.

E. Ashworth Underwood

Prof. V. Ulehla

The many-sided Czechoslovak man of science, Vladimir Ulehla, died on July 3 at the age of fifty-eight. His father had taken a prominent part, years ago, in securing educational reforms in Moravia, and Vladimir's interest in science was further developed under Prof. B. Němec at Prague and at the University of Strasbourg. After 1919, Dr. Ulehla became professor of plant physiology and biology at the newly founded Masaryk University of Brno. His original contributions to science relate mainly to a study of protoplasmic movement in lower organisms, and the influence of various ions on cells and their protoplasm. The borderline of plant and animal life, and the infusoria especially, interested him and he made some physico-chemical investigations on plant colloids and on turgor. Ulehla also wrote two books in Czech of a philosophical nature, "Reflexions on Life" and "Beyond the Veil".

But Ulehla's special merit was his skill in interesting the general public of his country in science and culture. His first great opportunity came when he was the organiser of the remarkable Brno Contemporary Culture Exhibition of 1928. Moravia was then a centre of archæological interest on account of the recent discoveries concerning the prehistoric mammoth hunters. Thanks to Ulehla's organising ability the exhibition, which attracted international attention, gave a clear impression of Czechoslovakia's cultural and scientific progress during the first decade of its independence.

Next, Ulehla turned his attention to the production of educational and cultural films, and those depicting the colourful peasant life and scenery of south-east Moravia, where the Slovak inhabitants cling to their traditional dress and old customs and folklore, were particularly successful.

In addition to his duties at Brno University, Ulehla was from 1928 until 1939 scientific correspondent of the daily *Lidové Noviny*, and he resumed this work in 1945 when the journal reappeared as *Svobodné Noviny*.

J. G. F. D.

We regret to announce the following deaths:

Sir Albert Howard, C.I.E., Imperial economic botanist to the Government of India during 1905–24, director of the Institute of Plant Industry, Indore, during 1924–31, on October 20, aged seventy-four.

Dr. Ellsworth Huntington, formerly research associate in geography, Yale University, an authority on the effect of climate on human racial development, on October 16, aged seventy-one.

NEWS and VIEWS

Physiology at Charing Cross Hospital Medical School: Prof. William Burns

Prof. W. Burns, recently appointed to the chair of physiology at Charing Cross Hospital Medical School, London, is a graduate in science and medicine of the University of Aberdeen. He received his early education at the Mackie Academy, Stonehaven, whence he entered the University in 1930. Having graduated B.Sc. in 1932 and M.B., Ch.B. in 1935, he was appointed to an assistantship in the Department of Physiology, and in 1938 became senior lecturer. As a teacher and demonstrator, Burns brought to an orderliness of thought and expression the valuable gift of artistic skill in illustration. Prof. Burns' first interest in research work centred around the problems of carbohydrate and cardiac metabolism, but it soon became manifest that his chief interests lay in the realm of the biophysical. Until 1942 he was engaged in investigating activity in afferent nerves associated with the viscera. The results of this work were incorporated in a thesis for which he was awarded the D.Sc. degree.

Early in 1942, Prof. Burns' biophysical and technical interests suggested a potential usefulness in the war effort, and in that year he was called to the Admiralty. After a period of service at the Admiralty research laboratory, he was appointed physiologist on the staff of the headquarters of the Royal Naval Scientific Service and latterly was placed in charge of the Royal Naval Physiological Laboratory. During the period of his war service, he was engaged on various problems such as the application of acoustics, the habitability of submarines, operational considerations affecting special equipment in warships, etc. In the latter years of his Admiralty service, he was also responsible for liaison between the Royal Naval Scientific Service headquarters and the activities of the Royal Naval Personnel Research Committee of the Medical Research Council, in which the latter is associated with the Admiralty in dealing with problems involving the relationship of man to the various duties and types of environments imposed by the requirements of the Navy.

Walter Holbrook Gaskell (1847–1914)

One hundred years ago, on November 1, 1847, Walter Holbrook Gaskell was born at Naples. Gaskell was a physiologist to whom medicine continues to owe a deep and lasting debt. He was a mathematician by training, and on Michael Foster's advice he went in 1874 to Leipzig to Ludwig's laboratory, in those days the most important centre of physiological research in Europe. On his return he took up physiology as a career, being appointed lecturer at Cambridge in 1883. Gaskell laid the secure foundation for our knowledge of the pathology of the heart and of the autonomic nervous system. In a series of ingenious and conclusive experiments he showed that the beat of the heart is due to automatic rhythmic contractions of the heart muscle and to the wave of excitation flowing from sinus venosus to bulbus arteriosus and from muscle fibre to muscle fibre. By his zigzag incisions of heart muscle he proved the continuity of the rhythmic wave. He introduced the terms and conceptions 'heart block', 'fibrillation', and 'gallop-rhythm' into the literature, and was one of the pioneers in the galvanometric investigation of the heart. In 1890, at the request of the Hyderabad Commission, he investigated the action of chloroform. His fascinating book "The Origin of Vertebrates" appeared in 1908. As a lecturer Gaskell was popular and inspiring, though he was not eloquent. A big man physically and intellectually, his strength and his weakness lay in his love of generalizations, which sometimes led him to victory and as often led him astray. He died on September 7, 1914, in his sixty-seventh year.

George Green, 1793–1841

As a mathematician, George Green is among the immortals; as a man he sank back almost at the moment of his death into the obscurity from which he had startlingly emerged. From a volume of studies published in 1946 as a tribute to George Sarton, Mr. Gwynedd Green, of University College, Nottingham, has separated a biography of the miller-scholar who graduated as fourth wrangler at the age of forty-four, nine years after the private publication of an incomparable masterpiece. Property is located, wills are transcribed, correspondence between Kelvin and Crelle is reproduced, and there are notes on every traceable name in Green's family tree and on all but eight of the fifty-two subscribers to the printing of the famous "Essay"; bibliographical information is thorough, but mention should surely have been made of the collected edition of Green's papers which was prepared by Ferrers for Caius in 1871 and reproduced photographically in Paris in 1903. The circumstances of Green's life both in Nottingham and at Cambridge have been investigated once for all from local sources with an industry beyond praise, and if a condescending patron and a resentful daughter are more vivid in the story than the central figure himself, this is because no contemporary portrait or character sketch has been found and the author does not attempt imaginary reconstructions. It is sad to learn from a note added in manuscript that the mill in which Green laboured and studied was reduced to a shell by fire in July last.

Department of Scientific and Industrial Research: Activities in Scotland

THE view has been held by many that great benefits could accrue from the establishment of branches of the existing stations of the Department of Scientific and Industrial Research, or of new laboratories, in different parts of Great Britain. By such developments, the work of these stations could be brought more intimately before the notice of industrialists, practising engineers and others, and it would be more convenient for them to obtain the greatest benefit from the researches in progress by the most effective method—that of direct consultation and discussion with the staffs concerned. There is also the important argument that the research establishments themselves would be able more readily to appreciate the needs of industrial concerns and authorities in different places.

Accordingly, the announcement recently made concerning the establishment in Scotland of the new Mechanical Engineering Research Station and of sub-stations for fuel, building and road research will receive wide approval. There is in Scotland, of course, a long and distinguished tradition of engineering activity of every description. In addition, there are schools of engineering science within its four universities and at various technical colleges. These schools have already established a high reputation for their teaching and for their original work; they are anxious to develop the research side of their function, and the closer contact afforded with the Department of Scientific and Industrial Research by the new developments will be helpful in this direction. Nor can it be denied that the Department itself will stand to gain from making its points of contact with all universities more numerous and more personal.

New Vegetable Research Station

THE first meeting of the governing body of the new Vegetable Research Station was held at the offices of the Ministry of Agriculture on October 8. Its incorporation as a company limited by guarantee and not having a share capital was decided on and an organising committee was set up to select suitable candidates for the post of director and to examine suitable sites for the Station; it is considered that an area of at least 300 acres would be necessary. The members of the governing body are Sir Edward Salisbury, Dr. W. G. Ogg, Prof. G. E. Blackman, Dr. H. V. Taylor, Mr. R. L. Scarlett, Dr. J. Barker, Prof. J. W. Munro, Prof. R. H. Stoughton, Prof. F. T. Brooks, Prof. T. Wallace, Prof. S. J. Watson, Prof. W. Brown, Dr. C. D. Darlington, Mr. E. H. Gardener, Mr. G. G. Hole, Mr. W. F. Swift, Mr. J. Laity, Mr. A. A. Clucas, Mr. David Lowe, Mr. J. Cracknell, Mr. F. A. Secrett and Mr. G. W. Giles.

Agriculture in the Caribbean

THE Anglo-American Caribbean Commission was set up in 1942 to encourage social and economic co-operation between the United States of America and its possessions and bases in the Caribbean, and the United Kingdom and the British Colonies in the same area. In 1945, the Governments of France and the Netherlands accepted an invitation to join this body, which has since become known as the Caribbean Commission. The committee set up by its Research Council to deal with problems connected with agriculture, nutrition, fisheries and forestry has circulated a number of crop inquiries to the various agricultural departments and is issuing a series of publications based on the replies. "Grain Crops in the Caribbean", the third in the series, is now available on request from the Caribbean Research Council, Caribbean Commission, Kent House, Port of Spain, Trinidad, B.W.I. For four hundred years the agricultural systems have been largely based on single-crop agriculture for the export market. The obvious dangers of this policy and the advantages of diverse cropping have been repeatedly pointed out, and the cessation of rice imports from Burma and India during the War forced attention on the necessity for producing more food for home consumption and the desirability of encouraging inter-Caribbean trade. With the exception of rice in the Guianas and maize in British Honduras and Jamaica, both acreage and production of grain crops are normally very small. Methods of cultivation are primitive, manures are rarely used and losses are heavy owing to inadequate storage facilities. The general conclusion from the inquiry, however, is that though greater attention to fundamental research is of the utmost importance, the introduction of machinery and the application of existing knowledge could immediately bring about a substantial increase in grain production without reducing the acreage devoted to export crops.

A Central Library of the World

A PROJECT for a Central Library of the World, drawn up during the German occupation of France, with the dual objects of providing more effectively for the preservation of the documents on which human culture rests and making their utilization easier and more widespread, is of interest in relation to the programme of work now contemplated by the United Nations Educational, Scientific and Cultural Organisation, which already includes a library organisation. Of the seven stages in which it was visualized the project would be achieved, the first, that of bringing together in France a limited number of initiators, both French and foreigners resident in France, had been realized; and a second, that of formulating a concrete project and inviting the collaboration of a number of well-known French personalities, was in progress when this pamphlet was issued by the French Association for the Study of Bibliographic Questions (7 rue des St.-Pères, Paris 7), as was the fourth stage of inviting foreign co-operation. The further stages include the formation of an international committee and, after study of the problem by that committee, an international convention to set up the appropriate organisation, appoint the members and to decide on the official language to be used.

The preliminary scheme summarized in this pamphlet contemplates the establishment of the organisation, to be called the Bibliothèque Centrale du Monde, by a statute guaranteeing the absolute inviolability of the headquarters of the Organisation, which is to be regarded as a world reserve; the territory where it is located should belong to no nation. The organisation would be directed by a supreme council, and administered by an administrative council. Its director would be provided with a general secretariat and would also be responsible for the administrative, principal and auxiliary services. Besides ordinary members of council, there would be from three to ten times as many corresponding members. The supreme council would function largely through two permanent commissions, one of which would be responsible for the study of projects. The chief services contemplated include the deposition and distribution of documents, and diffusion of information. In particular, it is suggested that the organisation should provide at its central depot a universal primary bibliography, and should endeavour to secure the creation of a universal copyright system. It seems that with the establishment of the United Nations Educational, Scientific and Cultural Organisation, the proposals should, in the first instance, be considered by that body, presumably at the instance of one or other of the national delegations.

Literature of Spectrochemical Analysis

THE American Society for Testing Materials, through its Committee on Spectrographic Analysis, has sponsored the publication of two indexes on the literature of spectrochemical analysis. The first, issued in 1940, covered the years 1920–39 and contained 1,467 references and a detailed subject index. The second, "Index to the Literature on Spectrochemical Analysis. Part II, 1940–1945", issued in January of this year, gives references to 1,044 publications on spectrochemical analysis that have appeared during the years 1940–45 inclusive. In addition, there are thirty-six references, for the years 1938 and 1939, that were omitted from the earlier Index. The references are arranged in chronological order, and for each year the material is listed in alphabetical order according to the authors. English titles are given for all the papers, but foreign book titles are left untranslated. In the earlier Index abstracts were not given but only references to the published abstracts of the papers. Because of the widely scattered nature of the literature, and because many libraries probably lack complete sets of foreign periodicals for the war years, a brief abstract is provided, in Part II, for every spectrochemical publication listed. In most cases the abstracts are quoted verbatim from *Chemical Abstracts*, but where necessary, by consulting other abstracting journals and the original articles, a more suitable abstract has been compiled. This painstaking and intensive work, both of maintaining and compiling the Index, has been done under the direction of B. F. Scribner and W. F. Meggers, of the National Bureau of Standards, Washington. A helpful, detailed subject index, which covers the content rather than the titles of the several papers, completes the Index.

It is somewhat surprising that in spite of war-time restrictions on publication and the difficulties of access to foreign journals so much work has been done in the field of spectrochemical analysis during the War. The choice of spectrochemical methods in preference to others can only be attributed to the simplicity, speed, sensitivity and economy of these methods—all vital factors in war-time applications. With the return of industrial competition, these methods should prove equally valuable, and all spectrographers will find both Part II and the earlier Index indispensable as reference handbooks. The Index is clearly printed and bound in a paper cover, though for reference purposes in the laboratory it would have been preferable to have had a much heavier binding. Abbreviations are used extensively, and although no explanatory list is provided, no real difficulty will be experienced in understanding the text. The addition of a list of the full titles and addresses of periodicals to which reference is made would perhaps be an improvement. Copies of the Index can be obtained from A.S.T.M. Headquarters, 1916 Race Street, Philadelphia 3, Pasadena.

Nature Lover: The Magazine of the Countryside

THE recent publication of volume 4, No. 1 of *Nature Lover*, the magazine of the countryside, marks the revival of a much-needed popular journal which deals with the natural history and archæology of the British countryside. The greatest merit of the journal is that it chooses good, representative subject-matter which is fairly easily available, thus bringing these rural sciences within the reach of everyman. The present number contains short, readable articles on the "Unity of Nature" by C. H. Warren, "Secretive Badgers" by B. M. Nicholas, "British Fritillary Butterflies" by L. H. Newman, "Jimmy the Lizard" by Frances Pitt, "The Numbers of Animals" by Brian Vesey-Fitzgerald, "Water Problems of Fishes" by Chapman Pincher, "Some Strange Plant Habits" by Wolseley Banks, "Bird-watching on an East Coast Estuary" by R. H. Harrison, "Lavenham, Suffolk" by Geoffrey Morgan. Among these authors are some of Britain's best natural history writers, and some of the articles are illustrated by good photographs. This monthly journal can be strongly recommended to the general lay reader who is interested in country-life and natural history, and it should be encouraged in all our secondary schools, for its method of presentation is bound to stimulate interest. Subscription to *Nature Lover* is 16*s.* 6*d.* a year, including postage. Further information can be obtained from *Nature Lover*, Staples House, Cavendish Place, London, W.1.

U.S. National Academy of Sciences: Officers

ACCORDING to the annual statement, the present officers and members of the Council of the U.S. National Academy of Sciences are as follow: *President:* Prof. Alfred N. Richards, professor of pharmacology, University of Pennsylvania; *Vice-President:* Dean L. P. Eisenhart, Graduate School of Mathematics, Princeton University; *Foreign Secretary:* Prof. Detlev W. Bronk, Johnson professor of biophysics, University of Pennsylvania; *Home Secretary:* Dr. F. E. Wright, Geophysical Laboratory, Carnegie Institution, Washington; *Treasurer*: Dr. J. C. Hunsaker, Departments of Mechanical Engineering and Aeronautical Engineering, Massachusetts Institute of Technology. *Other Members of Council:* Dr. Walter R. Miles, Prof. W. Albert Noyes, jun., Prof. I. I. Rabi, Dr. W. M. Stanley, Dean John T. Tate and Dr. D. D. Van Slyke.

Rook Behaviour during Incubation

CLOSELY studying a rookery of eight nests during the incubation period, C. M. Ogilvie noticed that the hen birds applied themselves almost exclusively to incubation, while excursions were rare and very brief. (*British Birds*, **40**, No. 5; May, 1947.) Feeding and coition, when this occurred, took place upon the nest. The cock bird was responsible for feeding the hen, a duty which was performed with characteristic ceremony at irregular intervals; intrusions within the colony and invasions from without were combated by the male birds. Coition was more often promiscuous than between mated pairs, and took the form of an assault resisted by the hen and countered by other cocks.

University of Leeds: Appointments

THE following appointments in the University of Leeds have been announced: Mr. E. A. Vaughan, lecturer in the Department of Social Studies; Mr.

A. Johnson and Mr. L. G. Johnson, lecturers in the Departments of Economics and Extra-Mural Studies; Mr. Edward Broadhead, lecturer in zoology; Mr. J. D. Jenkins, lecturer in mining; Mr. H. J. King, lecturer in surveying; Dr. W. J. Allen and Dr. R. A. Kenney, lecturers in physiology; Mr. S. Dagley, lecturer in biochemistry; Mr. G. A. Nelson, lecturer in pharmacognosy.

The number of full-time students enrolled for the present session is 2,804; the number of ex-Service students at present in the University is approximately 1,200. The present total of students compares with 1,736 in 1938; the number of arts students has increased very markedly owing to the number of students returning to complete courses interrupted by national service, but apart from this the increase is fairly uniformly spread over all departments and faculties.

University of Sheffield: Appointments

THE following appointments have been made in the University of Sheffield: Dr. A. S. C. Lawrence, senior lecturer in physical chemistry; Dr. H. J. Tress, lecturer in glass technology; H. Graetzer, assistant lecturer in mathematics; G. H. Jowett, assistant lecturer in statistics in the Department of Mathematics; J. R. Beattie, assistant lecturer in physics; Douglas W. Riley, assistant lecturer in chemistry; H. J. Whiteley, assistant lecturer in pathology.

The following resignations have been announced: Dr. J. Sinclair, senior lecturer in mining, who has been appointed to the chair of mining at University College, Cardiff; Dr. F. Bielschowsky, cancer research worker in the Department of Pathology under the British Empire Cancer Campaign, who has been appointed director of cancer research for New Zealand.

The Night Sky in November

NEW moon occurs on Nov. 12d. 20h. 01m., U.T., and full moon on Nov. 28d. 08h. 45m. The following conjunctions with the moon take place: Nov. 6d. 03h., Mars 4° S.; Nov. 6d. 07h., Saturn 5° S.; Nov. 11d. 20h., Mercury 0·03° S.; Nov. 14d. 01h., Jupiter 2° N.; Nov. 14d. 10h., Venus 1° N. In addition to these conjunctions with the moon, the following conjunctions also take place: Nov. 9d. 14h., Venus in conjunction with Jupiter, Venus 0·9° S.; Nov. 11d. 18h., Mars in conjunction with Saturn, Mars 0·9° N. Mercury is in inferior conjunction on Nov. 5 and becomes a morning star later in the month, rising at 5h. 40 m., and 6h. at the middle and end of the month, respectively. Venus, an evening star, sets about 17h. throughout November and can be seen very low in the western sky. Mars, in the constellation of Leo, rises at 23h. 08m., 22h. 52m., and 22h. 25m., at the beginning, middle and end of the month respectively, and is close to Regulus towards the end of November. Jupiter sets in the early evening hours and is unobservable. Saturn rises at 23h. 38m., and 21h. 50m. at the beginning and end of the month, respectively, and can be seen in the constellation of Leo, fairly close to Mars. Occultations of stars brighter than magnitude 6 are as follows: Nov. 1d. 04h. 25·5m., υ Taur. (*D*); Nov. 1d. 05h. 08·9m., υ Taur. (*R*); Nov. 1d. 19h. 53·0m., 103 Taur. (*R*); Nov. 2d. 05h. 33·2m., 118 Taur. *f*. (*R*); Nov. 7d. 04h. 32·1m., 46 Leon. (*R*); Nov. 21d. 18h. 17·3m., τ Aqar. (*D*); Nov. 26d. 20h. 37·0m., σ Arie (*D*); Nov. 29d. 23h. 33·0m., 139 Taur. (*R*). *D* and *R* refer to disappearance and reappearance, respectively, and the latitude of Greenwich is assumed. There will be an annular eclipse of the sun on Nov. 12, invisible at Greenwich.

Announcements

PROF. ARTHUR HOLMES, regius professor of geology in the University of Edinburgh, has been elected a foreign member of the Royal Swedish Academy of Sciences.

THE Kelvin Medal Award Committee, consisting of the presidents of the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, Naval Architects, Mining and Metallurgy, Mining Engineers, and Engineers and Shipbuilders in Scotland, and the Iron and Steel Institute, has awarded the Kelvin Gold Medal for 1947 to Air Commodore F. G. Whittle, in recognition of the eminent services he has rendered to engineering science in those branches of engineering work with which Lord Kelvin was especially identified. The Medal is normally presented triennially, but the last award was made in 1938 to Sir J. J. Thomson.

DR. JOSEPH ARONSON, of the United States Bureau of Indian Affairs, has been awarded the Alvarenga Prize of 1947 of the College of Physicians of Philadelphia, in recognition of his studies on the evaluation of BCG vaccine in the control of tuberculosis.

AT the invitation of the British National Committee, the fourth plenary World Power Conference will be held in London in 1950.

THE International Union of Biological Sciences, with the financial support of the United Nations Educational, Scientific and Cultural Organisation, is arranging a symposium on the role of trace elements in plant physiology, to be held at Rothamsted Experimental Station during November 5–6, 1947. Seventeen research workers from Australia, Denmark, Finland, France, Great Britain, Netherlands, Norway, Sweden, Switzerland and the United States have accepted invitations to attend. The report on this symposium will be published by the International Union.

THE Linnean Society of London, in conjunction with the Systematics Association, is organising a course of twelve weekly lectures on the "Principles and Methods of Taxonomy". Lectures will be given in the rooms of the Linnean Society on Wednesdays at 5.30 p.m., the first lecture being on October 29. Leading plant and animal taxonomists are contributing to the course, which is open to advanced students of biology. Further information can be obtained from the Assistant Secretary, Linnean Society of London, Burlington House, Piccadilly, London, W.1.

A FARADAY SOCIETY general discussion on "The Physical Chemistry of Process Metallurgy" will be held in the latter half of September 1948. It is intended that the discussion should be devoted to the thermodynamics and kinetics of the high-temperature reactions involved in smelting and refining, but excluding reactions which occur in mechanical working and heat treatment, and also electrochemical processes in aqueous solutions. Thermodynamics will include thermochemical, free energy and equilibrium studies, and kinetics will include both chemical reactions and diffusion processes. Prospective contributors should forward to the Secretary of the Society summaries of any papers they would like to submit not later than February 1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electron Microscope Studies of Normal and Malignant Tissues of High- and Low-Breast-Cancer Strains of Mice

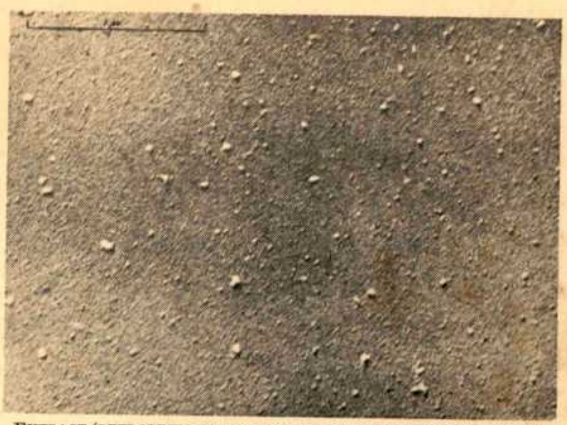
MAMMARY cancer in high-breast-cancer strains of mice has been shown by Bittner[1] to be transmissible to the offspring through the milk of the mother, and furthermore he has claimed[2] that all the tissues except the liver of high-cancer strains contain the same tumour-inducing factor as is found in the milk.

Barnum, Ball, Bittner and Visscher[3] described some of the physical properties of the milk factor present in tissues of mice of high-cancer strains. They found that petroleum ether does not destroy the tumour-inducing properties of tissues derived from high-cancer strains. They also observed that these properties remain unchanged at *p*H values between 5·0 and 10·2. According to Bittner[4], and confirmed by one of us (Dmochowski), extraction of breast-tumour tissue with distilled water is more efficient than with saline.

In June 1946, experiments were undertaken in order to examine with the electron microscope normal and malignant tissues obtained from high- and low-cancer strains.

Extracts of normal and malignant tissues from mice of *C3H*, Strong *A*, and *R*3 high-cancer strains, as well as of *C*57 black and *CBA* (which in this laboratory is a low-cancer strain), were prepared in the following way. Dried tissues were treated with petroleum ether, extracted with distilled water, treated with trypsin for 30 min. at 37° C., and filtered through Berkefeld *N* candles. The following tissue extracts were made: lactating breasts and breast tumours of *C3H*, Strong *A* and *R*3 strains; lactating breasts of *C*57 and *CBA* strains; breast tumours induced in *C*57 and in *IF* low-cancer-strain mice by methylcholanthrene; and also 37*S* transplantable sarcoma of the Imperial Cancer Research Fund, and a sarcoma induced in *C*57 by methylcholanthrene. In each case extracts of the same concentration were made, starting from equal amounts of dried tissue. Usually several tumours or lactating breasts from several mice of each strain were minced together and desiccated in the usual way[5]. In a few cases breast tumours and lactating breasts, each derived from a single mouse, were also examined. All extracts for electron microscopy were further diluted with filtered distilled water to a strictly comparable concentration, micro-drops were placed on filmed specimen grids, and the drops were drained immediately with a strip of filter paper to bring about rapid drying. After shadowing with metallic gold, the suspensions were photographed.

Results. Extracts of lactating breast tissues and of breast tumour tissues of *C3H*, Strong *A* and *R*3 strains were found to contain approximately spherical particles about 200 A. in diameter (see photograph). Extracts of lactating breast tissues from mice of *C*57 and *CBA* low-cancer strains, extracts of breast tumours induced in *C*57 and *IF* low-cancer strains by methylcholanthrene, and extracts of 37*S* sarcoma, were found to be free from such particles. Our results showed, therefore, that particles of about 200 A. diameter were consistently present in breast tissues and tumours of high-cancer strains, and consistently absent from those of low-cancer strains.



EXTRACT (PETROLEUM ETHER, DISTILLED WATER, TRYPSIN, BERKEFELD *N* CANDLE) OF *C3H* HIGH-CANCER STRAIN LACTATING BREAST TISSUE. GOLD-SHADOWED ON COLLODION FILM

Concurrently, all extracts were inoculated into *C*57 × *R*3 hybrid mice, susceptible to the development of breast cancer. The results of these biological tests are awaited.

Since this letter was ready for publication, it has come to our notice that Graff, Moore, Stanley *et al.*[6] have examined the milk of a high- and a low-cancer strain of mice and report finding a "characteristic material of large particle size" from the milk of their high-cancer strain and its absence or low concentration in their low-cancer strain. The significance of the difference in size between the particles encountered in the two laboratories is not clear at present, nor is the relationship between these particles and the tumour-inducing factor.

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Sept. 29.

[1] Bittner, J. J., *Science*, **84**, 162 (1936); *Amer. J. Cancer*, **30**, 530 (1937); *U.S. Pub. Health Rep.*, **54**, 1590 (1939); *Amer. J. Cancer*, **35**, 90 (1939); *J. Nat. Cancer Inst.*, **1**, 155 (1940).

[2] Bittner, J. J., *U.S. Pub. Health Rep.*, **54**, 1827 (1939).

[3] Barnum, C. P., Ball, Z. B., Bittner, J. J., and Visscher, M. B., *Science*, **100**, 575 (1944).

[4] Bittner, J. J., Amer. Assoc. Adv. Sci., Research Conference on Cancer, Washington, p. 80 (1945).

[5] Dmochowski, L., *Brit. J. Exp. Path.*, **25**, 138 (1944); **26**, 192 (1945); **26**, 267 (1945).

[6] Graff, G., Moore, D. H., Stanley, W. M., Randall, H. T., and Haagensen, C. D., 4th Intern. Cancer Research Congress, Sept. 2–7, 144 (1947).

Specimen Changes due to Electron Bombardment in the Electron Microscope

WE have recently observed changes in a number of substances, chiefly ionic crystals, when subject to intense electron bombardment in the electron microscope. While the results are not readily interpretable, they do suggest that the effects may not be entirely due to the heating effect of the electron bombardment. It is for this reason, as well as for recording a type of artefact that has hitherto received little attention in the literature, that we report them here.

Using a cathode-biased electron gun[1,2] on the electron microscope built in the University of Toronto in 1944[3], it has been possible to obtain current densities at the specimen of the order 1 amp. per cm.^{2}, with accelerating potentials of 40–50 kV. With specimens mounted on 100 A. 'Formvar' films, the following changes have been observed.

Sodium chloride, sodium chlorate, potassium bromide and potassium iodide. The crystals, originally opaque, became transparent under electron bombardment (Figs. 1, 2 and 3). A residue was left behind which we believe to be the contaminating material discussed by Stewart[4] and Watson[5]. In some cases (Fig. 4) a deposit was formed around the crystal during the above change, and occasionally this deposit would itself later become more transparent.

Silver chloride. Under bombardment these crystals became transparent and produced an extensive deposit around them of fine opaque particles. These particles under bombardment later coalesced into a series of 'veins' with tributaries.

Lead chloride. Following a suggestion from Dr. James Hillier, at the R.C.A. Laboratories, Princeton, N.J., we examined evaporated films of lead chloride. Under bombardment this material gathers into globules which move on the 'Formvar' film.

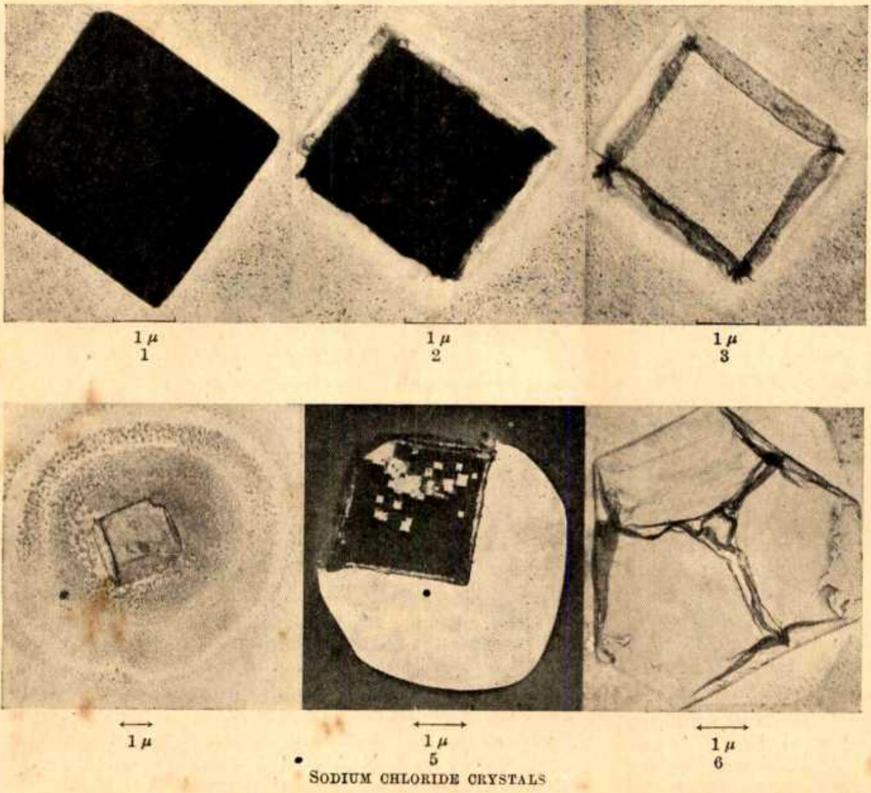
With both sodium chloride and silver chloride it has been observed on occasion that when a crystal is bombarded with electrons and becomes transparent, forming a deposit in its vicinity, other crystals within the deposit throw shadows. While at first sight it is tempting to attribute these changes solely to sublimation or melting of the crystals, there is evidence which makes this hypothesis doubtful. Hall[6] has determined the sublimation temperatures for the following substances *in vacuo*, the first temperature being for slow sublimation, the second for rapid sublimation : trinitro-*m*-cresol, 80° C., 90° C. ; anthracene, 105° C., 120° C. ; carbazole, 125° C., 130° C. ; anhydrous citric acid, 137° C. ; 150° C. melts, 150° C. boils. Hall has also examined the changes in the substances under bombardment in the electron microscope. Mounting them on 'Formvar' films and examining in our microscope, we concluded, in agreement with Hall, that specimen temperatures could be made as high as 150° C., but at this temperature the 'Formvar' films would begin to melt.

Calculations similar, though less detailed than those of Borries and Glaser[7], indicated that the temperature of the ionic crystals mentioned above would never be more than 10° C. in excess of the temperature of the supporting film. This implies that the temperature of the crystals is too low for sublimation at pressures of the order of 10^{-4} to 10^{-5} mm. of mercury.

To check this point sodium chloride crystals were mounted on a 'Formvar' film on a mesh and heated *in vacuo* outside the microscope. It was possible to melt the 'Formvar' film at the centres of the mesh openings without subliming the salt. The fact that the salt had not sublimated was established by shadow-casting the crystals before heating them and then examining the specimen in the electron microscope after heating it. There were crystals present for all the shadows present; yet after this it was possible to make some of these salt crystals disappear under electron bombardment without damaging the film.

In view of the difficulties of explaining these changes on a hypothesis of sublimation alone, we have considered that ionic migration may play a part in the change. Fig. 5 shows a crystal of sodium chloride at an intermediate state of the change. Had the process been sublimation, one would have expected those parts of the crystal more remote from the supporting film, and therefore at a higher temperature, to disappear first. The reverse seems to be the case, which is not unexpected if the phenomena is due to migration.

Fig. 5, incidentally, would seem to provide evidence in support of the theory of a mosaic texture of rock salt discussed by Ewald and Renninger[8]. In addition to the interest in the fundamental nature of this phenomenon, there is the possibility of employing it in the study of crystal surfaces, either by examining the residual contaminating layers (Fig. 6) as a replica of the surface, or by shadow-casting the crystals to produce an all-metal replica and then removing the crystal from the replica by electron bombardment within the microscope.



1 μ 1

1 μ 2

1 μ 3

1 μ

1 μ 5

1 μ 6

SODIUM CHLORIDE CRYSTALS

We hope to extend these studies and publish a fuller report on them in the future.

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S. G. **Ellis**

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July 22.

[1] Hillier, J., and Baker, R. F., *Appl. Phys.*, **17**, 12 (1946).

[2] Ellis, S. G., *J. Appl. Phys.* (in course of publication).

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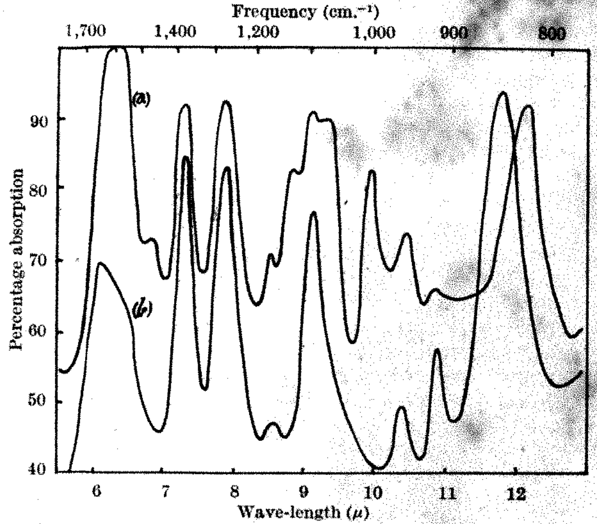
Use of Polarized Radiation in Infra-Red Analysis

In a recent communication in *Nature*, Elliott and Ambrose[1] have reported the use of a pile of selenium films for producing polarized infra-red radiation, and mentioned some interesting applications of their technique. They refer only to the previous work in this field of Ellis and Bath[2], who used a calcite prism, which restricts observations to the near region infra-red (up to 2·4 μ). The use of reflexion from a selenium mirror to produce completely polarized infra-red radiation over wave-lengths up to about 14 μ was discovered by Pfund[3] in 1906, and this method has been employed by several observers[4] in the examination of crystals of inorganic salts. We have for some time been using the Pfund reflexion technique very successfully in the study of oriented solids of organic materials. Until further details are available, it is not possible to decide whether a reflexion or a transmission technique is the more efficient with selenium, but it seems certain that the technique of producing, handling and transporting stout selenium mirrors is much easier than that required for delicate films a few microns thick.

Our results will be described in detail elsewhere, but it may be worth mentioning here that very significant differences have been observed in the spectra of thin oriented films of various polymers (for example, rubber, polythene, rubber hydrochloride and polyvinylidene chloride) for many of the bands between 6 μ and 15 μ, depending on whether the plane of polarization of the incident radiation is parallel or perpendicular to an axis along which orientation is occurring. We produced the orientation by stretching in the case of rubber and polythene, whereas for rubber hydrochloride and polyvinylidene chloride, it had already been produced by the rolling action used in making the film.

The orientation effect was checked by X-ray examination of the films and, as might be expected, the polarization effects were greatest in those cases where X-ray examination indicated a high degree of orientation. In certain cases, the interpretations of the changes in the absorption bands are quite clear. For example, the band at 6 μ in rubber arising from the stretching vibration of the C=C bond is intensified when the electric vector is parallel to the direction of stretching. Again, in polythene, the band at 6·9 μ due to the symmetrical deformation vibration of the hydrogens in the CH_2 groups is intensified where the electric vector is perpendicular to the axis of stretching. This is even more marked in the 13·9 μ band, recently shown[5] also to involve a deformation motion of the CH_2 group, and proves it to be perpendicular to the chain axis. The behaviour of the well-known hydrocarbon band at 7·3 μ (generally assigned to a symmetrical deformation vibration of the CH_3 group) appears to be anomalous and requires further investigation. As Elliott and Ambrose have remarked, the behaviour of many bands under polarized radiation may be a valuable guide in making assignments to particular modes of vibration in complex molecules for which a complete analysis of the spectrum is impracticable.

There is another aspect of the use of polarized infra-red radiation which does not yet seem to have been appreciated[6], namely, its use in conjunction with X-ray analysis to establish the orientation of a molecule in the unit cell of a crystal. Certain chemical bonds (for example, CH, OH, NH and C = C, C = O, C = N) give highly characteristic absorption bands in the infra-red; using polarization techniques, the actual orientation of such bonds can be established provided a molecule possesses in its spectrum a band which can be unequivocally assigned to a certain chemical bond or a definite vibration of a group, and thus the orientation of the whole molecule in the unit cell can be determined.



Spectrum of *p,p′* dibromodiphenyl ketone crystal with the electric vector (*a*) parallel to the *b*-axis, (*b*) perpendicular to that axis

We have recently had a good demonstration of this in the case of *p,p′* dibromodiphenyl ketone, the X-ray analysis of which is now being completed by Dr. Toussaint of the University of Liège. Dr. Toussaint required confirmation of his analysis, which placed the CO bond along the *b*-axis of the crystal. This we were able to provide, as shown in the accompanying figure, which gives the spectrum of the compound with the electric vector (*a*) parallel to the *b*-axis, (*b*) perpendicular to that axis. It will be observed that the CO band near 6 μ in case (*a*) shows 100 per cent absorption, whereas in case (*b*) it only reaches 70 per cent. The difference is much more striking than these figures indicate, because the crystal employed had to be very thick (about ten times that generally used for a CO band). The 70 per cent absorption in the perpendicular orientation is really a small residual effect due either to imperfection in the crystal or to incomplete alignment of the axis of polarization perpendicular to the *b*-axis of the crystal.

We are indebted to Dr. Toussaint for permission to quote his results before publication, and to Mr. Clews for help in carrying out X-ray examination of some of the polymer films.

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A. VALLANCE JONES

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Cambridge. June 28.

---

[1] Elliott, A., and Ambrose, E. J., *Nature*, **159**, 641 (1947).

[2] Ellis, J. W., and Bath, Jean J., *J. Chem. Phys.*, **6**, 221 (1938).

[3] Pfund, A. H., *Astrophys. J.*, **24**, 19 (1906).

[4] Cf. Schaefer, C., and Matossi, F., "Das Ultrarote Spektrum" (Springer, 1930).

[5] Sheppard, N., and Sutherland, G. B. B. M., *Nature*, **159**, 739 (1947).

[6] *Note added in proof.* Since this letter was submitted, a similar observation has been published by D. A. Crooks, *Nature*, **160**, 17 (1947).

Temperature Variation of the Second-Order Raman Spectrum of Crystals

INVESTIGATING at different temperatures the spectrum of second-order scattering of crystals of the alkali-halide salts, we have detected some new peculiarities in the intensity distributions. The region of small frequencies of the spectrum of second-order scattering depends far more strongly on the temperature than the region of large frequencies. The photographs and the microphotometrical curves of the spectrum of scattering of the rock-salt crystal obtained by us at 250° C. and 700° C., and reproduced in Figs. 1*a* and *b*, confirm this statement.

Figs. 1*a* and *b* show that the decrease of intensities observed at a low temperature (250° C.) in the region of frequencies from 60 cm.$^{-1}$ up to 200 cm.$^{-1}$ of the continuous spectrum (marked by an arrow) becomes scarcely noticeable at a high temperature (700° C.). The curve of intensity distribution rises considerably in this region, whereas the trend of the high-frequency part of the curve does not change significantly with temperature. Thus in the spectra of second-order scattering there are regions of frequencies which strongly depend on the temperature variation, as well as regions which depend considerably less on it.

The difference combinations of the frequencies are situated in the region of the continuous spectrum of scattering, which depends strongly on the temperature. Therefore we believe that the strong dependence on temperature of the region of small frequencies is due to the fact that the difference combination vibrations depend on the temperature in a different manner and far more strongly than the octave and sum combination frequencies, which lie chiefly in a part of the spectrum of scattering more removed from the Rayleigh line.

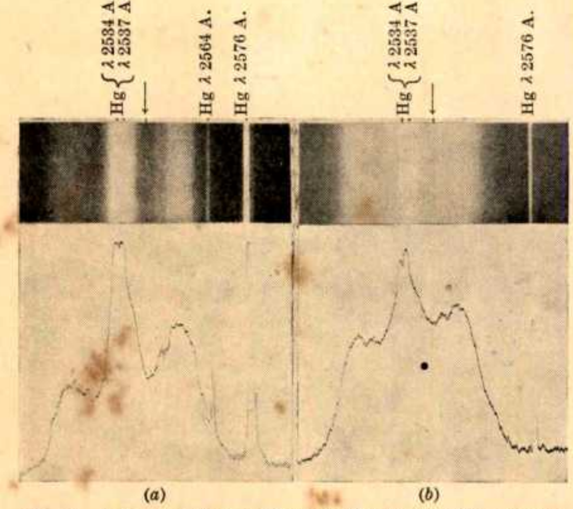

Fig. 1. SPECTRUM OF SECOND-ORDER SCATTERING OF A CRYSTAL OF HEATED ROCK-SALT, WITH (BELOW) MICROPHOTOMETRIC RECORD. (*a*) TEMP. 250° C.; (*b*) TEMP. 700° C.

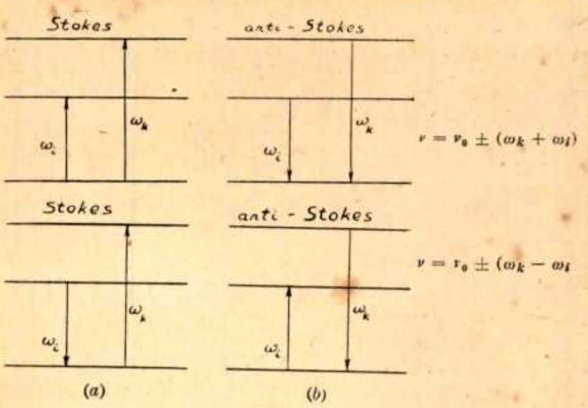
Stokes
anti - Stokes
ω_i
ω_k
$\nu = \nu_0 \pm (\omega_k + \omega_i)$
Stokes
anti - Stokes
$\nu = \nu_0 \pm (\omega_k - \omega_i$
(*a*)
(*b*)

Fig. 2

This strong temperature-dependence of the difference frequencies can be explained in the following way. At the appearance of the Raman spectrum of the second order, the incident radiation of the frequency ν_0 (the exciting quantum) interacts simultaneously with two proper vibrations of the lattice with the frequencies ω_i and ω_k. Either a Stokes or an anti-Stokes radiation in the scattered light of the frequency ν arises, owing to the exchange of the energies between the light quantum and the vibrations of the lattice. The energy transitions also taking place in the crystal lattice during these processes and leading to the formation of the sum and difference frequencies in the Raman spectra of the second order are illustrated by the schemes given in Figs. 2*a* and *b*.

Consideration of these schemes explains why the temperature-dependence of the intensity of the difference and sum frequencies must be different. It is well known that the anti-Stokes lines in the Raman spectrum of the first order are far more sensitive to variations of temperature than the Stokes lines. The appearance of the anti-Stokes lines involves the existence in the crystal lattice (or in the molecule) of excited vibrational states, and therefore the intensity of these lines is proportional to exp $(-h\omega/kT)$.

For the sum of combinational lines of the Raman spectrum of the second order, the observed intensity relationships must be near those of the first-order Raman spectrum. The intensity change of the Stokes sum lines with the temperature must be comparatively small (although stronger than for the Stokes lines of the same frequency of the Raman spectrum of the first order). The anti-Stokes lines of the sum frequencies will depend strongly on the temperature (although somewhat otherwise than in the Raman spectrum of the first order).

The Stokes difference frequencies differ sharply as regards temperature-dependence from the Stokes sum frequencies of the Raman spectrum of the second order. Fig. 2*b* shows that, for the difference frequencies, the appearance even of the Stokes lines is bound up with the existence of excited states of the lattice. Therefore, for the difference frequencies, the character of the dependence on the temperature of the Stokes lines in the scattering spectrum will be determined by an analogous factor exp $(-h\omega_i/kT)$, which usually characterizes the temperature-dependence of the anti-Stokes lines only. Consequently, the intensity of the Stokes difference lines rises very sharply with the temperature.

The dependence on the temperature of the intensity of the anti-Stokes difference frequencies of the Raman spectrum of the second order will be somewhat stronger than that of the lines of the same frequency in the Raman spectrum of the first order.

These simple descriptive considerations are in good agreement in general with the results of theoretical calculations of the temperature-dependence of the frequencies of the second-order scattering spectra carried out for the first time by P. P. Pavinsky[1].

Thus our investigations of the scattering spectra of heated rock-salt are in good agreement with the considerations we have discussed above.

In the spectrum of scattering of heated rock-salt the strong continuous background is clearly seen, especially in the region of small frequencies (from the Rayleigh line up to 200 cm.$^{-1}$). This affords further experimental confirmation of the correctness of the fundamental concepts of the Born theory of the crystal lattice.

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[1] Pavinsky, P. P., unpublished paper (1945).

Crystal Structures of *para*-Dinitrobenzene and *para*-Nitraniline

IN view of the rather surprising distortions reported in the dimensions of the *para*-dinitrobenzene molecule[1], a redetermination of this structure was recently attempted in this laboratory. The results of our preliminary two-dimensional survey did not point to a completely symmetrical molecule, but indicated that either (*a*) the planes of the nitro-groups may be slightly inclined (about 5°) to the plane of the benzene ring, or (*b*) the nitrogen – oxygen distances within the nitro-groups may not be equal, but differ by about 0·05 A. We were unable to distinguish between these alternatives by two-dimensional X-ray methods. In the meantime, we have learned that a full three-dimensional analysis of this structure has been undertaken elsewhere, so we have not pursued the matter further. The final results will be awaited with interest.

In the course of this work a certain resemblance was noted between the crystal structures of *para*-dinitrobenzene and *para*-nitraniline. For the former structure the space-group is $P2_1/n$, with two molecules in a unit cell of dimensions

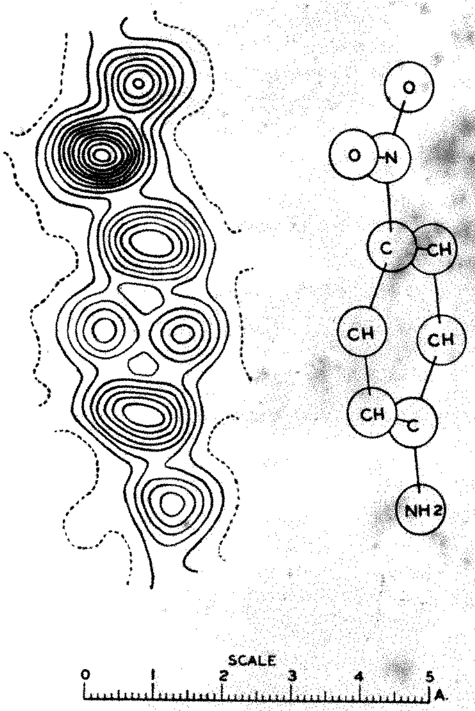
$$a = 11{\cdot}05 \text{ A.}, \ b = 5{\cdot}47 \text{ A.}, \ c = 5{\cdot}67 \text{ A.}, \ \beta = 92^\circ \ 18'.$$

The unit cell and space-group of *para*-nitraniline have already been determined by Prasad and Merchant[2], but if the space-group description is changed to $P2_1/n$, we obtain four molecules in a cell of dimensions

$$a = 12{\cdot}34 \text{ A.}, \ b = 6{\cdot}02 \text{ A.}, \ c = 8{\cdot}63 \text{ A.}, \ \beta = 91^\circ \ 40'.$$

The principal change is in the length of the *c*-axis, where the increase helps to accommodate the extra molecules. More detailed examination, however, shows that this apparent resemblance is somewhat misleading. In the *para*-dinitrobenzene structure there is a considerable concentration of atoms lying close to the $(10\bar{1})$ plane, whereas in *para*-nitraniline the greatest concentration is in the (101) plane. The actual inclination of the molecular plane to the (010) plane increases from 48° in *para*-dinitrobenzene to about 64° in *para*-nitraniline, although there is only a small increase in the length of the *b* axis.

The detailed structure of *para*-nitraniline has been elucidated by the method of trial and error, strong reflexions from the (800), $(50\bar{7})$ and $(70\bar{5})$ planes helping to define the molecular orientation. A refinement of the structure has been made by the double Fourier series method, and the electron density map for one molecule projected on the (010) plane is shown in the accompanying figure.



ELECTRON DENSITY MAP FOR *para*-NITRANILINE. CONTOURS AT UNIT ELECTRON DENSITY INTERVALS, THE ONE ELECTRON LINE BEING DOTTED

For this projection 110 terms in the (*h*0*l*) series were employed, and it gives good resolution for some of the atoms. The remaining co-ordinates may be determined from other similar projections; but further refinement is necessary before discussing the molecular dimensions in detail.

The preliminary parameters show that the distance between the amino-nitrogen atom and the oxygen atoms of the nitro-group of the molecule reproduced by the diagonal glide plane is 2·65 ± 0·05 A. This close approach shows that hydrogen bonding between the reactive groups of adjacent molecules is the main factor in stabilizing the structure.

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[1] James, King and Horrocks, *Proc. Roy. Soc.*, A, **153**, 225 (1935).

[2] Prasad and Merchant, *J. Ind. Chem. Soc.*, **15**, 47 (1938).

Crystal Structure of *Para*-bromochlorobenzene

THE structure of *p*-bromochlorobenzene has been investigated by Hendricks[1], who found the space-group to be $P2_1/a$, and the number of molecules in the unit cell to be two. In an exactly repeating crystal structure, this would make it necessary for the molecule itself to have a centre of symmetry, which is, of course, impossible. Hendricks suggested that the symmetry of the crystal might be statistical, the halogen positions in the molecules composing the structure being filled at random by bromine or chlorine, or perhaps the two possible orientations of any given molecule, differing by 180°, were equally probable.

It was decided to re-examine the crystal, in order to see if any evidence of faults or irregularities in the structure, which might give rise to diffuse spectra, could be found.

The compound crystallizes from acetone in thin plates, only the *a* faces being developed. The crystals are very volatile, and oscillation and Weissenberg photographs were taken with the specimen inside a gelatine capsule. The unit cell is monoclinic, with dimensions $a = 15{\cdot}2$ A., $b = 5{\cdot}86$ A., $c = 4{\cdot}11$ A., $\beta = 113°$, and contains two molecules. The space-group was found to be $P2_1/a$, in agreement with the results of Hendricks. Since the space-group has four general positions, only a statistical symmetry is possible, with a centre of symmetry at the centre of the average molecule. There was no sign of any diffuseness of the spectra, and the appearance of the photographs is consistent with a completely random occupation of the halogen positions by bromine or chlorine.

Two-dimensional Fourier projections were made on the *ab* and *ac* planes. For the first approximation, only the positions of the mean halogen atoms were assumed, and these were enough to fix the phases of most of the spectra. The fact that the benzene ring appeared in the preliminary projections indicates that the type of assumption made as to the nature of the structure is probably correct.

In the final projections, shown in Figs. 1 and 2, the atoms of the ring are clearly defined, although there is some false detail still at the centre of the ring, which probably has no particular significance, and may be due to the difficulty of allowing for the rather large absorption in the crystals, because of their flat shape. The height of the peaks in the *para* positions corresponds to a group with a scattering power the mean of that of chlorine and bromine.

The values of the atomic parameters are given in the following table:

	x	y	z
Br,Cl	0·169	0·173	0·466
C_1	0·081	0·356	0·482
C_2	0·095	0·533	0·666
C_3	0·013	0·676	0·678

They differ somewhat from those suggested by Hendricks, but are closely similar to those given by Bezzi and Croatto[2] for *p*-dibromobenzene, which has essentially the same structure. The sides of the benzene ring, which is regular, have a length of 1·41 A., and the carbon-halogen distance is 1·77 ± 0·04 A., a value nearly the mean of the C—Cl and C—Br distances, 1·69 A. and 1·88 A. respectively, found by de Laszlo[3] in electron diffraction work on the dichloro- and dibromo-compounds. It is also less than the C—Br of 1·84 A. given by Bezzi and Croatto.

In conclusion, I wish to express my thanks to Prof. R. W. James for his interest in this work, and to the South African Council for Scientific and Industrial Research, to which I am indebted for a grant.

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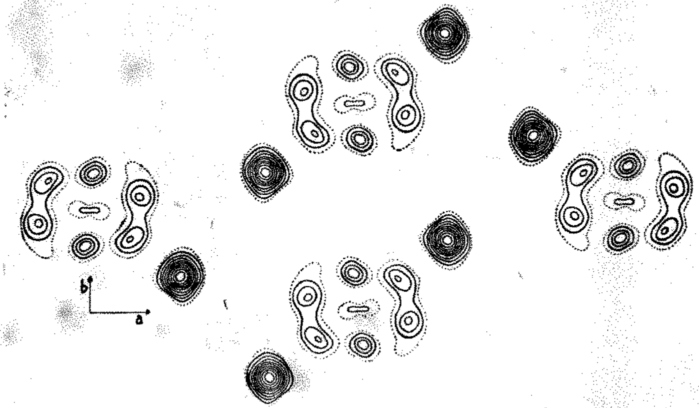

Fig. 1. PROJECTION OF ELECTRON DENSITY ON *ab* PLANE

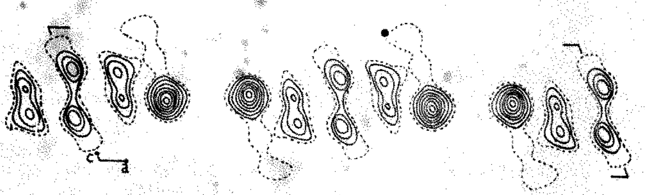

Fig. 2. PROJECTION OF ELECTRON DENSITY ON *ac* PLANE. CORNERS OF UNIT CELL ARE INDICATED

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[1] Hendricks, S. B., *Z. Krist.*, **84**, 85 (1933).

[2] Bezzi and Croatto, *Gazz. Chim. Ital.*, **72**, 318 (1942); *Chem. Zentr.*, **1**, 22 (1943); *Chem. Abstracts*, 3180^8 (1944).

[3] de Laszlo, *Proc. Roy. Soc.*, A, **146**, 690 (1934).

Purification of Renin by Means of Protein-Precipitating Agents

TRICHLOROACETIC acid has been used for denaturing and removing inert tissue proteins from kidney extracts containing renin[1]. It is also known that agents commonly used for removing proteins from solutions precipitate the proteins without causing denaturation in certain cases, so that the original protein may be regained. Thus trypsin and trypsinogen can be precipitated with trichloroacetic acid and the active enzymes regained[2]. In the same manner, crystalline egg albumin can be precipitated with metaphosphoric acid[3] and cathepsin by tungstic acid[4].

These investigations suggested to us the possibility of purifying renin by performing a fractional precipitation by means of such protein-precipitating agents. The blood pressure was determined by the capsular method[5].

(*A*) An extract of rabbit kidney purified by isoelectric precipitation of inactive proteins (*p*H 4·4) was prepared. 1·42 ml. corresponded to 1 gm. kidney. It gave an increase in blood pressure of 66 mm. mercury (1 gm. kidney per kgm. rabbit was used in all experiments) and contained 6·00 mgm. N (Kjeldahl) per gram of kidney.

(*B*) To 416 ml. of *A*, 10 per cent sulphosalicylic acid was added slowly at 0° to bring the extract to *p*H 3·0. After centrifugation, 447 ml. was obtained. 1 gm. kidney $\sim$ 1·52 ml. $\sim$ 4·05 mgm. N $\sim$ 68 mm. Hg.

(*C*) To 422 ml. of *B*, 7·5 ml. of 1·0 *M* sodium tungstate was added, followed by *N* hydrochloric acid to bring the extract to *p*H 2·1. The precipitate was isolated by centrifugation and dissolved in 30 ml. water with addition of sodium bicarbonate until neutral. Insoluble matter was discarded. Volume of centrifugate 38 ml. 1 gm. kidney $\sim$ 0·137 ml. $\sim$ 0·49 mgm. N $\sim$ 73 mm. Hg. After dialysis, 0·30 mgm. N.

The removal of inert proteins in *B* could be carried out with trichloroacetic acid, metaphosphoric acid and tungstic acid when suitable *p*H values were used, but sulphosalicylic acid was found to give the best yields. With this treatment most of the inactive proteins were removed. The tungstic acid precipitated at *p*H 2·1 all the active substance and left in solution almost all the nitrogen-containing substances of low molecular weight. In this manner it is very easy to obtain a concentrated purified solution of renin free from the bulk of tissue proteins and from low molecular impurities, and at the same time to avoid dialysis and concentration by evaporation.

These features, together with the great variability of the conditions for precipitation of proteins by such protein-precipitating agents, as compared with the usual methods (salt precipitation, alcohol precipitation, etc.) where it is the properties of the solvent which are changed, seem to make this a very convenient method which can be adapted to the fractional precipitation of a large number of proteins. Our preliminary experience suggests that the method might be of great value in the purification of biologically active proteins and enzymes.

This work was aided by a grant from Teknisk-kemisk Fond. Details will be published elsewhere.

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June 26.

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[1] Katz, G. J., and Goldblatt, H., *J. Exp. Med.*, 78, 67 (1943). Dexter, L., Haynes, F. W., and Bridges, W. C., *J. Clin. Invest.*, 24, 62 (1945).

[2] Kunitz, M., and Northrop, J. H., *J. Gen. Physiol.*, 19, 991 (1936).

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[4] Anson, M. L., *J. Gen. Physiol.*, 23, 695 (1940).

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Properties of the Fibrinokinase-Fibrinolysin System

IT was recently discovered that animal tissue cells contained an activator capable of transforming profibrinolysin into fibrinolysin[1]. The following properties of this enzyme system have now been found.

Two methods of investigating the action of the fibrinolysin were used. In the first method a 2–3 mm. thick layer of fibrin was prepared in a Petri dish (diameter, 10 cm.) from solutions of ox fibrinogen[2] (7 ml.), phosphate buffer (*N*/15, *p*H generally 6·5, 7 ml.) and ox thrombin[3] (50 units, obtained from Løvens kemiske Fabrik, Copenhagen). On these plates drops of the active solutions were placed. The plates were left standing 24 hours at 39°. In the second method the fibrinolysin was mixed with the fibrinogen solution before adding the thrombin, and the clot was made in a test-tube. The time in minutes for the fibrin to dissolve at 39° was measured. For the second method more potent solutions have to be used, but it permits a quantitative determination.

Fibrinokinase. The animal tissue retains its activating properties after grinding with sand and several washings with distilled water. No activator could be extracted from the tissue with the following solutions: phosphate buffer (*N*/15, *p*H 5·6–8·3), 0·9 per cent sodium chloride, acetic acid (1 per cent and 5 per cent), hydrochloric acid (0·01–0·1 *N*), ammonium hydroxide (0·01 *N*), sodium hydroxide (0·01 *N*) and glycerine (87 per cent) containing 0·5 per cent acetic acid.

The washed tissue pulp could be dehydrated with alcohol and acetone and dried with ether without destroying the activity. As a rule, a dry powder, prepared from pig's hearts, was used as activator. The tissue fibrinokinase is most stable at neutral and slightly acid reaction; at alkaline reaction it is destroyed slowly. Heating at 56° destroys it slowly, and at 70° immediately (5 min.).

The fibrinokinase activities of different tissues have been investigated, using various animal species as well as different organs. Small tissue fragments were placed on fibrin plates, and the diameter of the zone of dissolved area was used as a measure of the activity.

Tissues from calf embryo, pig and rabbit were usually found to be the most active, those from ox and rat were slightly less active, human and mouse only moderately active, while tissue from chicken and hen showed almost no activity. Of the organs, lung, heart and kidney were usually the most active. Pig's heart especially showed very high activity, while rabbit's heart was less active than other organs from rabbit. Liver and spleen were only slightly active. Stroma from erythrocytes (human) was very active.

Profibrinolysin. While the treatment (24h., 39°) of ox plasma or serum with fibrinokinase results in no activity because of a potent antifibrinolysin in the albumin fraction, the globulins prepared by 0·33 saturation with ammonium sulphate yield a very potent enzyme solution. The profibrinolysin contained in these globulin solutions is not completely precipitated by dialysis against tap water. It is rather stable against heating and changes of *p*H (stands heating to 56° for half an hour, but is slowly destroyed at 70°). Bovine profibrinolysin cannot be activated by streptokinase. Human profibrinolysin is activated by tissue fibrinokinase, but not to the same extent as with streptokinase.

Fibrinolysin. Bovine fibrinolysin is completely precipitated by dialysis against tap water, after which usually a considerable increase in activity is found. It is less stable than the profibrinolysin, being completely destroyed by heating to 70° in five minutes and slowly at 56°. It is thus possible to destroy the fibrinolysin without destruction of the profibrinolysin.

The activation may be carried out between *p*H 4 and *p*H 10 without any significant change in the activity after 24 hours incubation.

The *p*H optimum for the fibrinolysis is rather narrow, the activity being at its highest at about slightly acid reaction (*p*H 6·0–6·5).

The properties of the fibrinolysin formed seem identical with the properties of the fibrinolysin prepared by chloroform treatment.

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β-Glucuronidase and Tissue Proliferation

IN a previous communication[1] it was shown that β-glucuronidase in liver or kidney rises following administration of toxic agents to mice, depending upon the organ or organs affected. It was suggested that a rise in this enzyme is associated with tissue repair rather than the damage itself. This view is confirmed by results for kidney following administration of mercuric nitrate or chloroform to male mice. In each case, the rise in the enzyme did not occur in the early stages of poisoning, but was seen when repair was well advanced.

Age	Treatment	Interval following treatment, days	G.U.*/gm. moist tissue			Histological findings
			Spleen	Liver	Kidney	
Adult	None	—	580	280	380	—
,,	2 gm. chloroform/kgm.	1	1079	939	194	Damage and repair in liver; necrosis without evidence of repair in kidney.
		8	746	711	628	Residual damage and advanced repair in liver and kidney.
,,	20 mgm. mercuric nitrate/kgm.	1	—	436	208	Severe damage without evidence of repair in kidney; liver almost normal.
		3	718	469	808	Repair almost complete in kidney; some cell division in liver.
,,	Sub-total hepatectomy	3	—	1052	—	Very active cell division in liver.
		5	—	882	—	
		8	—	1165	—	
1 day	None	–	5100	1370	881	—
5 days	,,	–	3245	1363	793	—
13 ,,	,,	–	1521	2218	606	—
15 ,,	,,	–	5169	1239	727	—

* One G.U. (glucuronidase unit) liberates 1 μgm. phenol from 0·015 *M* phenol glucuronide at 38° and *p*H 5·2 in 1 hr.

That there is a relation between tissue proliferation and β-glucuronidase is further borne out by the fact that high enzyme contents were found in the livers of adult mice following sub-total hepatectomy, and in the liver, spleen and kidneys of baby mice. These results, which are summarized in the table, may provide a simple explanation of the finding by Fishman and Fishman[2] that administration of œstrogens to ovariectomized mice causes a rise in uterine glucuronidase, and of the high figures for tumour glucuronidase recently described by Fishman[3].

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[1] Kerr, L. M. H., and Levvy, G. A., *Nature*, **160**, 463 (1947).

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Formation of Cellulose by *Acetobacter acetigenum*

BROWN[1] isolated from 'mother of vinegar' an organism which he designated *B. xylinum* because it formed a tough pellicle exhibiting the behaviour of cellulose. It is now known as *Acetobacter xylinum*. In more recent years, X-ray examination of the pellicle which it forms on media containing, in the several cases, glycerol and certain sugars and sugar alcohols, has shown the material to possess the same structure as vegetable cellulose (compare Hibbert and Barsha[2], Tarr and Hibbert[3], Barsha and Hibbert[4] and Khouvine[5]).

Acetobacter acetigenum, a related micro-organism, also forms a pellicle, the nature of which does not seem to have been studied. Recently, in the course of another investigation, Dr. D. Kulka working with one of us (T. K. W.) isolated a strain of *A. acetigenum* which was remarkable for the large amount of pellicle-material produced during its growth in a glucose yeast–water medium in the presence of calcium carbonate; in one experiment the dry weight of the pellicle accounted for 60 per cent of the weight of glucose initially in solution.

This strain grows well at 30° in certain natural and also synthetic media of *p*H value about 5, and it can utilize a large variety of substances as sources of energy. The pellicle from cultures on malt-wort gave the principal reactions of cellulose. Pellicles were collected from cultures grown on solutions of inorganic salts containing ammonium sulphate as the source of nitrogen, and, in the several cases, containing the following substances as the source of energy: glycol, glycerol, mannitol, arabinose, xylose, glucose, fructose, galactose, maltose, lactose, sucrose and soluble starch. The pentoses and the soluble starch afforded only slight pellicles; in the other cases the yield of material varied from 2 to 8 per cent on the carbon source. The pellicles from the pentoses and from starch were not examined in detail; chemical tests for cellulose, which were made with all the others, were positive. Further, on X-ray examination the purified pellicles gave the diagram of crystallites which is obtained on X-ray examination of cotton cellulose. When the membranes were dried under strain they showed preferred orientation. On hydrolysis with dilute sulphuric acid, the material gave glucose, characterized as the 2:4-dinitrophenylosazone, m.p. and mixed m.p. 264°. On acetolysis of pellicle matter with acetic anhydride, acetic acid and sulphuric acid, at room temperature for 15 days, penta-acetylglucose was obtained in 25 per cent yield.

The production of cellulose from ethylene glycol by *A. acetigenum* is of particular interest in view of a suggestion of Kluyver that in certain cases glycollic aldehyde may be polymerized to sugar by bacteria; compare also the suggestion of Hibbert and Perry[6] that glycol may be the precursor of carbohydrates in Nature. Wirth and Nord[7] detected pyruvic acid in cultures of a *Fusarium* species on pentoses. They assumed the other fission product of the pentose molecule to be glycollic aldehyde, but they did not succeed in isolating the latter. During this bacterial synthesis of cellulose from glycol, it was found possible to trap glycollic aldehyde and to characterize it as the 2 : 4-dinitrophenylosazone, m.p. above 310°. The bacterial conversion of glycerol to cellulose involved the formation of dihydroxyacetone. This was characterized as the phenylosazone, m.p. and mixed m.p. 132°, and also as the 2 : 4-dinitrophenylosazone, m.p. and mixed m.p. 284°.

We are indebted to Dr. H. Lipson, who gave us facilities for the preparation of X-ray photographs.

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Detection of Acetic Acid in *A. niger* Growing on a Glucose Medium

MANY different views have been expressed concerning the chemical steps by which certain species of *Aspergillus* and of *Penicillium* convert glucose into citric acid. Some of the earlier hypotheses are now only of historical interest, and those modern views for which a reasonable amount of experimental support can be adduced have one feature in common, namely, the presumption that acetic acid is an essential intermediate. Up to the present time, however, the occurrence of this acid in cultures of *A. niger* on sugar does not appear to have been demonstrated. We have made many attempts to detect its presence in the metabolism solution, but without success, an outcome not entirely unexpected in view of the ease with which *A. niger* metabolizes acetic acid in the presence of sugar (compare Pfeffer[1]).

We succeeded, however, in demonstrating the presence of this acid in the mycelial mat of young cultures at the time when formation of citric acid had just commenced. Acetic acid was separated from the mycelium after the cells had been ruptured by grinding them with sand. Using three strains of *A. niger*, we obtained in each case only about 0·3 gm. of the acid from mycelial mats grown, in the separate experiments, on 5 litres of culture liquid. The latter consisted initially of a 12 per cent solution of glucose plus the requisite inorganic salts. A fourth strain of *A. niger* gave much higher yields, and on two occasions similar experiments afforded 2·35 gm. and 2·60 gm., respectively, of acetic acid. It was characterized as the silver salt and also as the *p*-nitrobenzyl ester, m.p. and mixed m.p. 78°.

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Utilization of Citric Acid by some So-called Citrate-non-Utilizing Bacteria

KOSER[1] showed that all types of *B. coli* are capable of growth in a simple medium in which ammonium phosphate constitutes the source of nitrogen, and a fermentable carbohydrate such as glucose or lactose is the source of carbon; when citric acid is substituted for the carbohydrates, growth occurs only with the sub-group known as *Aerobacter-Cloacœ*. Growth in such medium, called Koser's test, has since become one of the basic criteria in differentiating the Koser-negative *E. coli* from the Koser-positive members of the *Escherichia* tribe.

Certain laboratory and clinical facts led us to surmise that in presence of nitrogen compounds, other than ammonium phosphate, citric acid might be utilized even by Koser-negative organisms. In order to test this hypothesis, a typical *E. coli* and a typical *E. aerobacter* were cultured in a variety of media to all of which citric acid (30 mgm. per 100 c.c.) was added. Citric acid was estimated by a modification of the pentabromacetone method of Pucher, Sherman and Vickery[2]; and a decrease in citric acid content of the culture flasks (as compared with a sterile medium control) was taken as the index of utilization of citric acid. Cultures and controls were incubated both at room and incubator temperatures for a period varying from 1 to 4 days.

It was first found that, despite good growth, *E. coli* does not utilize appreciable amounts of citric acid in a glucose-ammonium phosphate medium (0·1 per cent ammonium phosphate with 0·2 per cent glucose); thus the presence of a readily available source of carbon does not induce *E. coli* to utilize citric acid. Moreover, it was found that in this medium *E. aerobacter*, which utilizes citric acid in the absence of glucose, does not attack citric acid until practically all the glucose has been broken down. In a basic medium of 0·1 per cent asparagine in saline (*plus* citric acid) growth of *E. coli* is not much heavier than in the glucose-ammonium phosphate medium; however, it is found that in 48 hours, 15 per cent of the citric acid has been used by *E. coli* and 94 per cent by *E. aerobacter*. Identical figures were obtained when the asparagine content was raised to 1 per cent. On the other hand, in 2 per cent peptone water (B.D.H. peptone) 94 per cent of citric acid was used up by *E. coli* but only 60 per cent by *E. aerobacter*. Under similar conditions a strain of *Staphylococcus aureus* did not utilize citric acid.

It is thus clear that the failure of *E. coli* to grow in Koser's medium does not result from a fundamental incapacity of the organism to use citric acid either as a sole or additional source of carbon, since *E. coli* has been proved to be capable of utilizing citric acid under suitable conditions. It is thought that such conditions are provided by an appropriate hydrogen acceptor in the medium, and it is hoped to bring forward evidence in support of this hypothesis.

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* This work was carried out by N. Conway during the tenure of a McCunn Research Scholarship.

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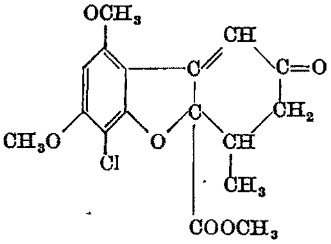
Identity of Griseofulvin and 'Curling-Factor'

WHEN *Penicillium janczewskii* is grown in liquid culture media a substance is produced which causes stunting, excessive branching and characteristic distortions in the germ tubes of *Botrytis allii* and other fungi[1]. The substance has been isolated and called 'curling-factor'[2]. When some preliminary observations[3] were made on the chemical and physical properties of curling-factor, the presence of chlorine was overlooked and a formula $C_{20}H_{20}O_8$ was proposed. We find that chlorine is present and that curling-factor is identical with griseofulvin $C_{17}H_{17}O_6Cl$, which was isolated several years ago by Oxford, Raistrick and Simonart[4] from *Penicillium griseofulvum* (for curling-factor found: C 58·4; H 4·9 per cent; mol. wt. 362; OCH_3 23·2; Cl 9·8 (micro) and 9·7 (macro) per cent; CH_3—(C) 4·9 per cent; calculated for $C_{17}H_{17}O_6Cl$: C 57·9; H 4·9 per cent; mol. wt. 352·7; OCH_3 26·4 (for three OCH_3); Cl 10·1; CH_3—(C) 4·3 (for one CH_3) per cent). The melting point (220°) of a sample of griseofulvin which was kindly supplied to us by Prof. Raistrick was not depressed by mixing with curling-factor (m.p. also 220°); and further, griseofulvin is identical with curling-factor in its biological properties[5].

Most of the chemical reactions described by Oxford, Raistrick and Simonart have been carried out with curling-factor. A mono-oxime has been prepared; hydrolytic experiments have yielded griseofulvic acid, decarboxygriseofulvic acid and norgriseofulvic acid; and oxidation gave a chloro-hydroxy-dimethoxybenzoic acid.



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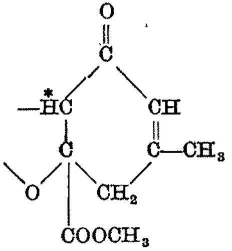

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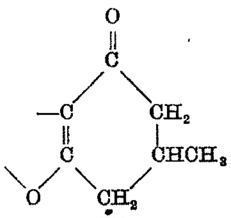

III

The formula (I) for griseofulvin was suggested[4] tentatively as a working hypothesis and accounts for most of the reactions very well. We find, however, that decarboxygriseofulvic acid forms complexes which appear to be oxonium salts, and the complexes are not formed until the carboxyl group is removed. The structure III would be expected to yield oxonium complexes and is readily derived from II by the migration of two hydrogen atoms after hydrolysis and decarboxylation. Other evidence seems to be in favour of the slight modification of part of structure I shown by II. Formula II, unlike I, readily explains the production of orcinol on alkali fusion. In II one of the centres of optical activity indicated by * should undergo fairly ready racemization through enol formation. This might explain the easy production of an isomer of griseofulvin.

All the analyses were carried out by Drs. Weiler and Strauss with the exception of the chlorine estimations, for which we are indebted to Mr. J. Haslam, of I.C.I. Plastics Division.

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[1] Brian, P. W., Hemming, H. G., and McGowan, J. C., *Nature*, 155, 637 (1945).

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A Fungistatic and Bacteriostatic Red Pigment Produced by a Strain of the *Penicillium nigricans-janczewskii* Series

Two distinct strains of the *Penicillium nigricans-janczewskii* series have been isolated from Wareham Heath soil[1]. One of these strains, regarded as typical of the species *Penicillium janczewskii* Zal., has been shown[2] to produce a substance causing marked abnormality of fungus growth; this substance has since been found to be identical with the previously known mould product griseofulvin[3]. The other strain, distinct from *P. janczewskii* and not definitely assignable to any of the described species within the *P. nigricans-janczewskii* series, has been shown to produce fungistatic and bacteriostatic culture filtrates on Raulin-Thom medium. A red pigment possessing antibacterial and fungistatic properties has now been isolated from such filtrates.

For the production of this pigment, cultures are incubated at 25° C. on shallow layers of medium for five days, when spore germination assays[4] show an activity of 16–32 B.A. units/ml. The culture filtrate is then extracted with chloroform and the extract evaporated to dryness. The residue is crystallized from ethanol, giving about 8 mgm. of crude red pigment per litre of culture filtrate.

By recrystallization from ethanol, glistening red needles are obtained. These begin to darken at 120° C. but do not melt at 380° C., nor is there any tendency for sublimation to occur at this temperature. The red pigment contains no nitrogen or halogen, and highly purified samples leave no ash on combustion. There are some indications of the presence of sulphur, but quantitative analysis has shown the amount present to be insignificant.

• Microanalyses carried out by Drs. Weiler and Strauss on material three times recrystallized from ethanol and dried to constant weight *in vacuo* give results in good agreement with an empirical formula $C_5H_4O_2$ (found: C = 61·8, 62·5, 62·7; H = 4·04, 4·50, 4·34 per cent; S = nil. $C_5H_4O_2$ requires C = 62·5; H = 4·20 per cent). A methoxyl determination indicated the presence of one methoxyl group per $C_{10}H_8O_4$, and this or some multiple of this unit would seem to be the most probable molecular formula. A Kuhn–Roth oxidation gave 8·6 per cent (C)—CH_3 and a Zerewitinoff determination 0·46 per cent active hydrogen. $C_{10}H_8O_4$ requires (C)—CH_3 = 7·8 per cent (for one); active hydrogen = 0·52 per cent (for one).

The red pigment is readily soluble in hot ethanol but sparingly soluble in the cold. It is slightly soluble in cold benzene, pyridine, glacial acetic acid and 1 : 4 dioxane, giving orange solutions. The orange dilute aqueous solution which is weakly acid turns yellow when made alkaline with caustic soda, and if the solution is now re-acidified it becomes almost colourless, the latter reaction being reversible. The pigment dissolves in concentrated sulphuric acid forming a green solution, and in concentrated nitric acid forming an orange solution which is decolorized on standing. With concentrated hydrochloric acid a deep crimson solution is produced which deposits violet needles on standing. These and other reactions indicate the formation of oxonium salts.

In nutrient broth at *p*H 7·0 the red pigment prevents growth of *Staphylococcus aureus* at a concentration of 50 µgm./ml. Germination of *Botrytis allii* conidia is prevented by 0·4 µgm./ml. of red pigment at *p*H 3·5. Aqueous solutions are extremely unstable; if solutions with an initial antifungal titre of 128 B.A. units/ml. are stored at *p*H 3·5 for 24 hours at 25° C., activity falls to 16 B.A. units/ml., and at *p*H 6·5 or above to less than 1 B.A. unit/ml.

We have some evidence that the mould also produces another antibiotic substance; further chemical and biological investigations are proceeding.

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[1] Brian, P. W., Hemming, H. G., and McGowan, J. C., *Nature*, 155, 637 (1945).

[2] Brian, P. W., Curtis, P. J., and Hemming, H. G., *Trans. Brit. Mycol. Soc.*, 29, 173 (1946).

[3] Grove, J. F., and McGowan, J. C., see preceding communication.

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Formation of Uranium Hydride

THE formation of uranium hydride (UH_3) by the action of hydrogen on massive uranium metal between the temperatures 150° and 375° C. has been described by Burke[1].

We have found in further investigations that UH_3 would form at lower temperatures. The hydrogen used was tank hydrogen purified by passage over heated copper turnings and silica gel. 10 gm. of massive uranium metal were placed in tubes which were filled with 72 c.c. hydrogen at N.T.P. The tubes were large enough to ensure the presence of sufficient hydrogen to cause complete transformation. In all cases the reaction occurred only after an apparently quiescent period, which, especially at low temperature, lasted much longer than the reaction proper.

Temperatures (°C.)	Approximate time for complete formation of UH_3
250	2 hr.
200	2 hr.
150	5 hr.
125	12 hr.
100	24 hr.
75	60 hr.
50	~1 week
20	~2 weeks

Apparently uranium and hydrogen in contact are metastable even at room temperature.

Experiments were initiated to find whether the formation of uranium hydride might provide a means of separating from irradiated metal some, at least, of those fission products which form volatile hydrides, or belong to the rare gas group.

50 gm. of massive metal were irradiated for two weeks using 5 gm. radium–beryllium in paraffin. The metal was then heated in an evacuated system to 200° C. and hydrogen was slowly passed over the metal, after which the gas went over silica gel in a liquid air trap. After the metal had been completely transformed into hydride, the hydrogen was flushed out with argon and the silica gel examined for activity. None was found.

It thus seems that not even rare gases formed in fission are released during the transformation of massive uranium into uranium hydride.

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[1] Burke, J. E., U.S. Atomic Energy Commission Report MDDC-280 (declassified October 10, 1946).

Action of Per-Acids on the Iso-Octenes

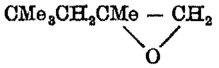
HICKINBOTTOM[1,2] finds unsaturated alcohols are formed in the treatment with per-acids of 2 : 4 : 4 trimethyl pentene-1 (I) and -2 (II) and also in the acid hydrolysis of the epoxide (IV) derived from the latter olefin. The object of this note is to show that these results do not, as Hickinbottom claims, throw any light on the double-bond shift observed in the air oxidation of some organic compounds, but can readily be accounted for by the formation of ionic intermediates. The action of the per-acids gives initially the epoxides (III and IV) by addition of oxygen to the double bond[3].

$CMe_3CH_2CMe = CH_2$

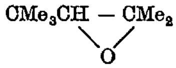
I

$CMe_3CH{=}CMe_2$

II



III



IV

$CMe_3CH_2\overset{\oplus}{C}MeCH_2OH$

V

$CMe_3CHOH.\overset{\oplus}{C}Me_2$

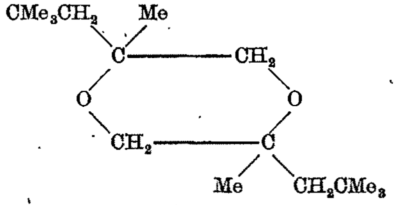
VI

The epoxides add a proton and the oxonium complexes formed react as the ions[4], V and VI. These ions are primary and secondary alcohols respectively since the C—O bond broken is such as to form the relatively stable isopropyl-type carbonium ion[5]. The subsequent reactions of these intermediate ions depend on the experimental conditions.

1. *Proton Loss.* V may lose a proton either from the methyl or methene group to give the two unsaturated alcohols observed by Hickinbottom, namely, $CMe_3.CH_2C(CH_2OH) = CH_2$ and $CMe_3CH = CMe.CH_2OH$. Only one unsaturated alcohol, as observed, is to be expected from VI, namely, $CMe_3.CHOH.CMe = CH_2$.

2. *Anion Addition.* Glycols result from the addition to V and VI of OH^-. In the acetic acid hydrolysis of IV, mentioned by Hickinbottom, the addition of OAc^- will give the 2 acetoxy 3-ol iso-octane.

3. *Condensation with Alcohol or Epoxide.* Ether-type compounds result from the interaction of, for example, VI with IV, yielding the neopentyl substituted 1 : 4 dioxan (VII), in general conformity with Hickinbottom's observation.



VII

Hickinbottom's work on the iso-octenes throws little light on the double-bond shift sometimes observed in the air oxidation of olefins[6]. The latter is accepted as due to the reaction of the intermediate free radical in its various resonance forms. Hickinbottom's observations, on the other hand, may be ascribed to the formation and subsequent reactions of an isopropyl-type carbonium ion.

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[1] Byers and Hickinbottom, *Nature*, 158, 341 (1946).

[2] Hickinbottom, *Nature*, 159, 844 (1947).

[3] Waters, "The Chemistry of Free Radicals" (Oxford University Press, 1946), p. 245.

[4] Hammett, "Physical Organic Chemistry" (McGraw-Hill Book Co., Inc., 1940), Chap. 10.

[5] Evans, A. G., *Nature*, 158, 593 (1946).

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DR. BREMNER's suggestions for the mechanism of the formation of unsaturated alcohols from epoxides must await further experimental work to determine the real value of his deductions. In one respect, Dr. Bremner's scheme is doubtful. It might reasonably be expected that the carbonium ions V and VI would lose a proton from the oxygen more readily than from a methyl group, to form carbonyl compounds with or without an alteration in the carbon skeleton.

It has been generally agreed that the free radical hypothesis of the peroxidation of olefins can provide an explanation of the formation of unsaturated hydroperoxides. It has the very serious defect of failing to account for the epoxides and dimeric material which are also formed during autoxidation. The rearrangement of the carbon skeleton which is observed when cyclic olefins undergo autoxidation in acetic acid is a further difficulty. Indeed, the free radical, hypothesis, so far from generally being accepted, is in need of extensive revision.

The object of the suggestion put forward in my note is to provide an alternative hypothesis which, moreover, has the merit of lending itself to experimental investigation.

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Aug. 13.

Absolute Values of the Rates of Unimolecular Reactions

N. B. SLATER has recently discussed this subject[1]. Some time ago, I treated the same problem[2] not in terms of the normal modes of the molecule, but of the individual bonds where the kinetic energy is expressed as a mixed quadratic form and not as a pure sum of squares. The result, then, seems to permit of an easily visualized interpretation, namely, that the rate constant depends only on the force constant of the breaking bond, the energy required to rupture it, and on the two masses of the atoms adjacent to the breaking bond. It does not depend at all on the remainder of the molecule, which simply acts as a temperature bath. Thus the result is the same as for a diatomic molecule for which the temperature-independent constant is found to be *exactly* equal to its vibrational frequency.

Quantum treatment will slightly modify this[2] in so far as, especially with light hydrogen atoms, part of their mass is to be added to the mass of the heavier atom to which they are attached. Thus in a paraffin, a C—C end bond should crack less readily than any of the inner C—C bonds, as the end carbon atoms are more heavily loaded with hydrogen.

Reverting to the classical treatment, it is interesting to note that the temperature-independent factor of the rate constant for a large molecule is in general not equal to one of its proper frequencies, but is equal to the frequency of the imaginary diatomic molecule corresponding to its fissile bond.

I have verified in the case of a linear chain of four equal atoms and equal bonds for motions only along the line joining them, that Slater's result can also be expressed in this simple manner. The conjecture that the rule stated above holds in all cases seems very probable; I have not proved it generally but verified it in many cases.

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[1] Slater, *Nature*, 159, 264 (1947).

[2] Pelzer, *Z. Elektrochem.*, 39, 608 (1933).

IF the internal kinetic and potential energies of the molecule are

$$T' = \tfrac{1}{2} \sum_{1}^{n} \sum a_{rs}\dot{q}_r\dot{q}_s \; , \; V = \tfrac{1}{2}\sum_{1}^{n} \sum b_{rs}q_rq_s, \qquad (1)$$

and if the oscillations of a particular co-ordinate q_1 (which is to break if it reaches a critical length q_0) are given by

$$q_1 = \sum_{1}^{n} \alpha_s\sqrt{\varepsilon_s} \cos (\lambda_s t + \varphi_s),$$

where $\lambda_s/2\pi$ is the frequency, and ε_s the energy, in the sth normal mode of vibration, then it can be shown that

$$\alpha^2 \equiv \Sigma\dot{\alpha}_s^2 = 2/b \ , \ \Sigma\alpha_s^2\lambda_s^2 = 2/a, \qquad (2)$$

where a, b denote the ratios of the determinants $|a_{rs}|$, $|b_{rs}|$ to the co-factors of a_{11}, b_{11} respectively.

Thus, in my previous expression[1] for the high-pressure unimolecular rate, namely,

$$K = \nu \exp(-E_0/kT), \qquad (3)$$

where

$$\nu = \sqrt{(\Sigma\alpha_s^2\lambda_s^2)}/2\pi\alpha \ , \ E_0 = q_0^2/\alpha^2, \qquad (4)$$

the frequency ν and dissociation energy E_0 are, by (2),

$$\nu = \sqrt{(b/a)}/2\pi \ , \ E_0 = \tfrac{1}{2}bq_0^2. \qquad (5)$$

The result (3), (5) can also be obtained by a generalization of Pelzer's earlier work[2] on chain molecules.

In the particular case where co-ordinate q_1 is the extension of a bond between two atoms of masses m_1,m_2, then

$$a = m_1m_2/(m_1 + m_2) \equiv m^*, \qquad (6)$$

which is the 'reduced mass' of m_1,m_2 for relative motion along their join. If also there are no cross-terms in V between q_1 and the other co-ordinates, so that

$$2V = b_{11}q_1^2 + \sum_2^n \Sigma b_{rs}q_rq_s, \qquad (7)$$

then

$$b = b_{11}. \qquad (8)$$

Hence in this case, by (5),

$$\nu = \sqrt{(b_{11}/m^*)}/2\pi \ , \ E_0 = \tfrac{1}{2}b_{11}q_0^2. \qquad (9)$$

This ν is the frequency of the "imaginary diatomic molecule corresponding to its fissile bond" (atoms m_1,m_2 with potential $\tfrac{1}{2}b_{11}q_1^2$). Thus Pelzer's conjecture is true when the potential energy is of the form (7); this includes the case[2] of a chain molecule with V a pure sum of squares. A gas of these "imaginary diatomic molecules" would, of course, dissociate at the unimolecular rate (3) only if the pressure were extremely high, but this does not impair the usefulness of Pelzer's conception.

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[1] Slater, *Nature*, 159, 264 (1947).

[2] Pelzer, *Z. Elektrochem.*, 39, 608 (1933).

A New Source of Taraxerol

IN the course of an investigation for alkaloids in *Litzea dealbata* (Lauraceæ) in this laboratory, it was noticed that from the alcoholic extract of the bark small crystals separated. Purification of these yielded a white product, m.p. 269–270° C., which gave a red-violet colour in the Liebermann–Burchardt test.

The melting point of this material and its two derivatives, the benzoyl and acetyl, together with the rotation and analysis of each, indicated that it was identical with the triterpene, taraxerol, isolated by Burrows and Simpson[1] in 1938 from the roots of *Taraxacum officinale*.

As the yield from this latter source is small and the purification from other triterpenes present tedious, little chemical work has been reported on the substance. The yield from *Litzea dealbata* being good and the purification simple, and there being, apparently, no other triterpenes present, it is intended to investigate some aspects of the chemistry of this substance.

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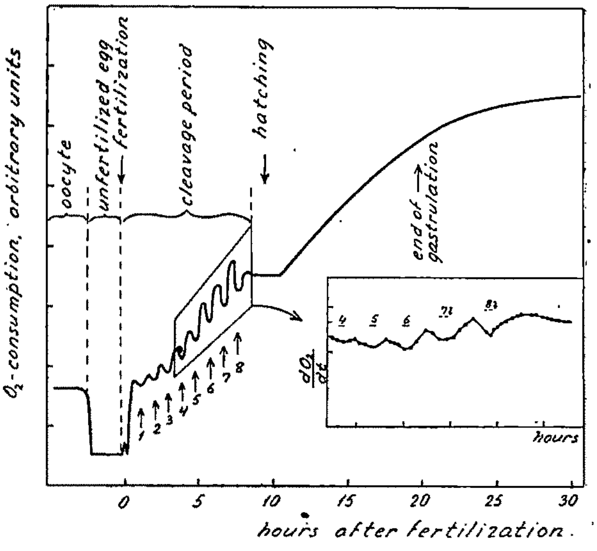
[1] Burrows, S., and Simpson, J. C. E., *J. Chem. Soc.*, 2042 (1938).

Respiration and Cell-Division in Eggs of the Sea Urchin, *Psammechinus miliaris*

As described in previous publications[1,2], we have found, by using modified Cartesian divers, that the frog's egg during cleavage respires rhythmically. The cleavage furrow invariably appears during a period of increasing respiration, the increase, however, being only slight, namely, 7–11 per cent. Single frog's eggs were used for these experiments, and the first three cleavages only were studied.

The experiments have now been continued and extended to eggs of the sea urchin, *Psammechinus miliaris*. The technique employed was a further development of that described[1], but about 200–300 eggs, dividing synchronously, were used for each experiment. The eggs were studied (at 16° C.) during the eight–nine hour period from just before the first cleavage until hatching; at least eight successive cleavages occur in this period. According to Lindahl[3], the well-known increase in respiration intensity during this period follows an S-shaped curve. I have found, however, that Lindahl's curve has waves superimposed on it, one wave accompanying each mitosis. The cleavage furrow always appeared when the respiration intensity was low. The respiratory variations accompanying the later cleavages were definitely more pronounced than those accompanying the first cleavages, the latter being of the same order as in the frog egg. According to Lindahl, hatching occurs during a period of almost constant respiration, and I have found the respiratory waves to disappear altogether just before hatching, which itself is followed by no change at all in respiration intensity.

In the accompanying figure, the inset small graph describes one experiment on about 300 sea urchin



eggs, dividing synchronously. The periods during which the cleavage furrow appears in all eggs are indicated by horizontal lines, and the cleavage numbers are given above the corresponding lines. Only cleavages 7 and 8 could not be actually observed in the microscope.

In the main figure the first part of the curve represents the respiration intensity of the oocyte and the unfertilized egg according to Lindahl and Holter[4]. As first described by Warburg[5] and afterwards confirmed by many others, an increase in respiration intensity occurs just after fertilization. The part of the curve describing this increase is based on the results of Laser and Rothschild[6], Runnström[7] and others. During subsequent development, the respiration intensity increases according to Lindahl's curve, but the mitotic rhythm described is superimposed upon the *S*-shaped part of it. It should be emphasized that after hatching the mitotic activity of the germ is most probably very much reduced.

Thus, in the sea urchin egg as well as in the frog egg, the early cell divisions appear to be accompanied by distinct respiratory variations, the biochemical significance of which, however, remains to be elucidated. In developing anthers, Erickson[8] found the respiratory intensity to vary in rhythm with the mitoses.

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Rearing of *Trombicula acuscutellaris* Walch

In a previous communication[1] some successful feeding experiments with the adults of *Trombicula acuscutellaris* Walch on the eggs, ovaries and adults of *Mansonia* (*Mansonioides*) *uniformis* (Theobald) (*Tæniorhynchus* (*M.*) *uniformis*) were described. Since then, further proof of the carnivorous habits of this species has been obtained and adults have been fed on freshly killed Collembola and psocids. They are unable, however, to trap living Collembola or psocids, and it is unlikely that in Nature such active insects would be utilized as food. But for the routine feeding of nymphs and adults in the laboratory, it has been found more convenient to use culicine eggs, and for this purpose the eggs of *Culex fatigans* Wied. have been very largely used. These eggs are eaten with great avidity, and an ovipositing adult is capable of eating fifty or more eggs in 24 hours. By way of contrast, it may be mentioned that an adult of *T. deliensis* Walch, which is less than half the size of *T. acuscutellaris*, rarely eats more than two to four eggs in 24 hours and has never been known to exceed a maximum of nine eggs in that time.

The ease with which engorged larvæ could be reared to the nymphal stage in excavated glass blocks containing damp cellulose wadding has been previously recorded[2]. It has been found just as easy to rear nymphs to the adult stage on a diet of culicine eggs using the same technique. Oviposition commences within 10–12 days of the emergence of the adults. The eggs, which vary in colour from orange to reddish-orange, are invariably hidden by the female at the time of oviposition. The cellulose wadding gives them the opportunity of doing this, and it has been found that oviposition ceases if the wadding is changed to filter paper or plaster of Paris as recommended by Michener[3].

The eggs, which hatch in 10–12 days, are picked out from the wadding in the glass blocks and placed on several thicknesses of wadding in specimen tubes measuring 2 in. × ½ in. The wadding is then soaked with water up to the eighth day, after which cotton wool is wrapped around the inside of the cork. This takes up any excess moisture and prevents the larval mites from being trapped in droplets of moisture condensing in the tube.

White mice have had to be used as hosts, although they occasionally die, possibly as a result of being attacked by the mites, particularly when the numbers found attacking them are relatively large. This species is, however, not known to transmit *R. orientalis*.

The mice are placed in a wire cage the dimensions of which are 3 in. × 1 in. × 1 in., with a ¼-in. mesh. If the cage is big enough for the mouse to move its front legs freely, wadding is packed in at the rear end so as to prevent this; otherwise the actively moving larval mites are vigorously brushed off the face and ears by the mouse. The cage is placed on a platform of wire mesh resting on a wire frame ¾ in. high, which in turn is placed in a circular glass dish 6 in. in diameter and 2 in. in depth.

The tube containing the larval mites is vigorously tapped so that all the mites are shaken to the bottom. The tube is then uncorked and the mites tapped out of the tube on to the head of the mouse. A glass cover is placed over the dish. The mouse is released from the cage about 17 hours later and placed in a fresh dish. In general, only about 20 per cent of engorged larvæ are recovered from the host. The majority of unengorged larvæ, owing to their extreme motility, are found running about the dish and glass cover on the second day and are discarded. From the second day onwards, a layer of cellulose wadding is placed in the dish and damped daily with 25 c.c. of water, the glass cover being removed after the first day. Engorged mites are found trapped in the damp wadding from the third to the seventh day, the largest number of mites being obtained on the fourth day. The mouse is fed on dry bread for the first four days and thereafter on damp bread.

Larval mites of *T. acuscutellaris* generally attach themselves to the inside of the ears, particularly the meatus, around the vibrissæ and to the upper and lower eyelids. The body of the host is only occasionally chosen as a site of attack.

This species has been reared to the fourth generation using this technique. A complete account of this investigation will be published elsewhere.

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β- AND γ-RADIATION FROM U^{239} AND Np^{239}

By PROF. HILDING SLÄTIS

IN connexion with the discovery of the transuranic element $_{93}Np^{239}$, McMillan and Abelson[1] report 0·47 MeV. as the upper energy limit of the β-spectrum. The γ-radiation was found to be complex and the energy less than 0·3 MeV. Philipp, Riedhammer and Wiedemann[2,3] studied the β-spectrum of Np^{239} photographically by means of the semicircular method. They found ten internal conversion lines. Eight of them were interpreted as the *K*-, *L*- and *M*-lines of three nuclear γ-radiations of the energies 208, 226 and 276 keV., two lines as the *L*- and *M*-lines of a *K*α-radiation. The results are reproduced in the accompanying table. Later, Philipp and Riedhammer[4] reported that the β-spectrum is a single one and that the β-decay is connected also with a 500 keV. γ-radiation. Recently, Feather and Krishnan[5] investigated the radiation from U^{239} by absorption measurements. They found, in the main, a single β-spectrum and give the value 1·20 MeV. for the upper energy limit. A γ-radiation of 76 keV. energy and another of at least 300 keV. were also observed.

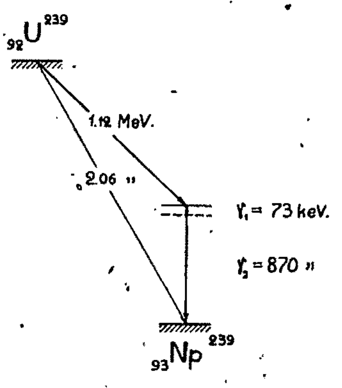

Fig. 2. NUCLEAR-LEVEL SCHEME FOR THE DISINTEGRATION OF U^{239}

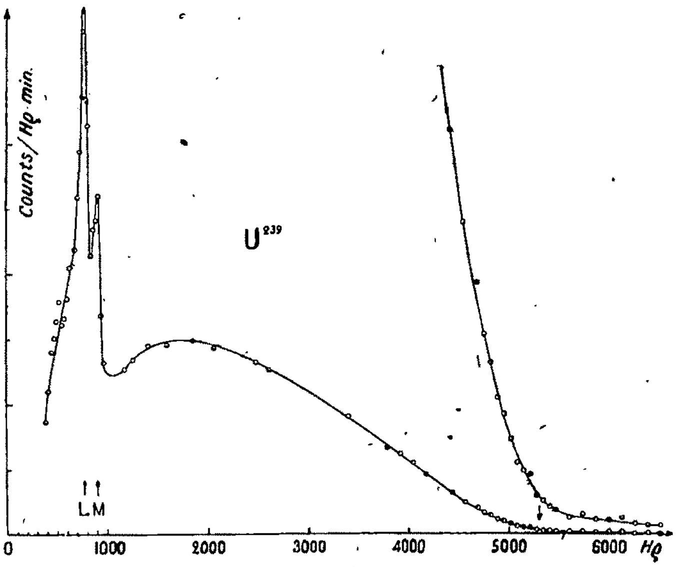

Fig. 1. β-SPECTRUM OF U^{239}

In the spring of this year I investigated the radiations from U^{239} and Np^{239}. Uranyl salicylaldehyde-*o*-phenylenediimine was irradiated with slow neutrons, and the U^{239} and Np^{239} formed were concentrated according to a technique developed by Melander[6]. Absorption measurements in lead showed that the γ-radiation from U^{239} consists of two components of energies 920 and 80 keV. Similarly, the γ-radiation from Np^{239} was found to consist of three components, 500, 200 and 51 keV.

The β-spectra were studied in a magnetic lens spectrograph constructed by K. Siegbahn[7]. The spectrum of U^{239} (Fig. 1) showed two internal conversion lines at 50·7 and 67·8 keV. They constitute *L*- and *M*-lines of a nuclear γ-radiation. The former gives the value 73·0 keV., and the latter 73·5 keV. for the energy of this γ-radiation. A Fermi analysis showed that the β-spectrum is double, with the upper energy limits 2·06 and 1·12 MeV. The difference, 0·94 MeV., corresponds to the higher value found by the absorp-

β-RAY LINES OF Np^{239}

No. of line	Notation	Philipp, Riedhammer, Wiedemann				Slätis		
		Hρ	*Eβ* (keV.)	*Eγ* (keV.)	Remarks	*Hρ*	*Eβ* (keV.)	*Eγ* (keV.)
1	L_1					631	33·9	56·8
2	L_2					671	38·2	61·1
3	L_3					724	44·2	67·1
4	M_1					766	49·2	55·1
5	M_2					818	55·7	61·6
6	M_3					861	61·4	67·3
		970	74·6	97·3	$L_{K\alpha}$ fairly weak	—	—	—
7	K_4	1050	86·2	206·2	medium	1022	84·8	206
		1090	92·4	98·3	$M_{K\alpha}$ weak	—	—	—
8	K_5	1164	105·0	225·0	strong	1152	105·8	227
9	K_6	1445	153·0	273·0	,,	1421	154·3	275
10	L_4	1615	186·9	209·6	fairly weak	1578	185·4	208
11	L_5	1696	203·5	226·2 209·4	$= L_5$ } medium $= M_4$ }	1670	204·0	227 210
12	M_5	1774	221·6	227·5	weak	1760	223·0	229
13	L_6	1936	254·4	277·1	medium	1905	255·0	278
		2010	271·0	276·9	$= M_6$ weak	—	—	—

	Electrons			Electrons		
	K	*L*	*M*	*K*	*L*	*M*
W = Ionization work in Pu =	120	22·7	5·87	121	22·9	5·91

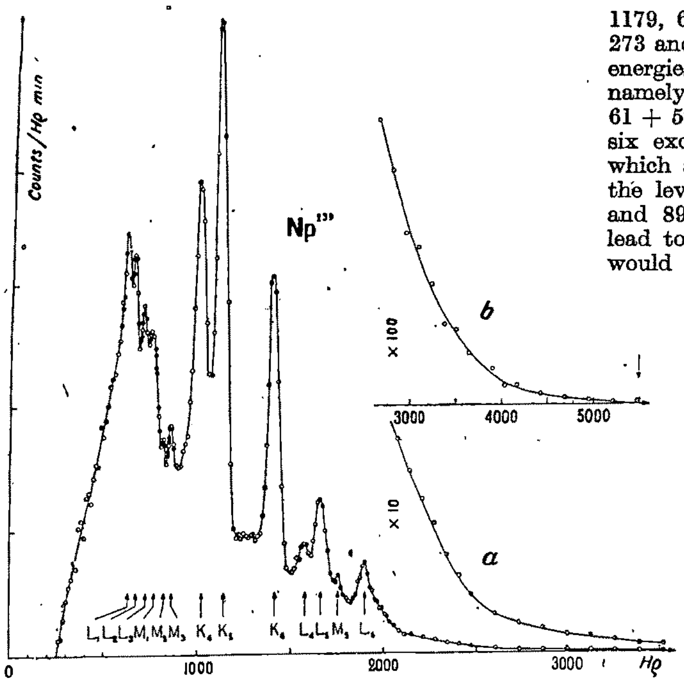

Fig. 3. β-SPECTRUM OF Np^{239}

(a) PART OF THE β-SPECTRUM, WHEN THE COUNTS ARE MULTIPLIED BY 10; (b) END OF THE β-SPECTRUM, WHEN THE COUNTS ARE MULTIPLIED BY 100

tion measurements, while the internal conversion line obviously answers to the lower one. These results lead to a disintegration scheme, in which the greatest part of the β-decay leads to an excited Np-nucleus, while a small part leads to the ground-state (Fig. 2).

In the β-spectrum of Np^{239} (Fig. 3) thirteen internal conversion lines were found. Seven of these (see table) are connected with the three nuclear γ-radiations 206, 227 and 275 keV. found by Philipp, Riedhammer and Wiedemann[3]. The six other lines are L- and M-conversion lines of three new γ-radiations of the energies 57, 61 and 67 keV. The L- and M-lines of the $K\alpha$-radiation in Pu^{239} were not found in the β-spectrum of Np^{239}, but appeared strongly in the spectrum of photo-electrons, released in a lead radiator. A Fermi analysis of the β-spectrum showed that it was fourfold with the upper energy limits 1179, 676, 403 and 288 keV. The differences, 503, 273 and 115 keV., correspond to the sum of pairs of energies computed from the internal conversion lines, namely, $503 \approx 275 + 227$, $273 = 206 + 67$, $115 \approx 61 + 57$. Therefore, the Pu^{239} nucleus seems to have six excited levels (Fig. 4), the differences between which are 275, 227, 206, 67, 61 and 57 keV. Thus the levels have the energies 275, 502, 708, 775, 836 and 893 keV. The β-decay of Np^{239} would chiefly lead to the 775 keV. level, while the other decays would lead to the levels 893, 502 keV. and the ground-state. Hence the γ-quanta would be emitted in cascade, 2, 4 and 6 in succession. An edge in the spectrum of the photo- and Compton-electrons released in lead gives evidence for a cross-over transition from the 775 keV. level to the ground-state in the Pu-nucleus.

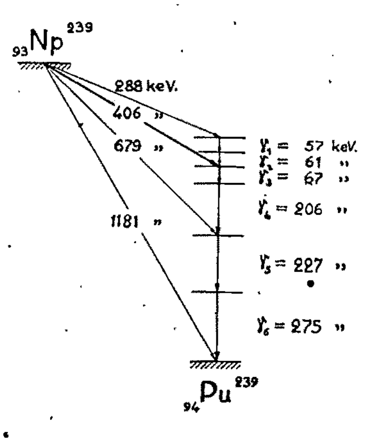

Fig. 4. NUCLEAR-LEVEL SCHEME FOR THE DISINTEGRATION OF Np^{239}

A detailed account of these investigations will be published in the near future[8].

I wish to express my thanks to the head of the Nobel Institute for Physics, Prof. Manne Siegbahn, by whose kind offices my stay in Stockholm was made possible. I am also indebted to the Nobel Foundation for fellowship grants made to me. My thanks are equally due to Dr. Lars Melander, who has carried out the chemical preparations, and to Dr. Kai Siegbahn for valuable discussions.

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INFRA-RED SPECTRUM AND MOLECULAR STRUCTURE OF PHTHIOCERANE

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THE properties of phthiocerane, the hydrocarbon derived from the wax alcohol phthiocerol[1,2] of the tubercle bacillus, for a pure specimen of which we are indebted to Prof. R. J. Anderson, Yale University, indicate a branched-chain structure[3], probably a long chain with a methyl side-chain near one end[4]. For comparison with phthiocerane, a series of hydrocarbons having a total of 34, 35 and 36 carbon atoms*, with a methyl side-chain in position 2-, 3-, 4-, or 5- from one end, have been synthesized at Uppsala, partly by the use of new synthetic methods[5]. The melting points of the synthetic hydrocarbons are plotted in Fig. 1 (the data for the n-hydrocarbons

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* The analytical data for phthiocerol do not allow a decision between the formulæ $C_{34}H_{67}(OH)_2OCH_3$ and $C_{35}H_{69}(OH)_2OCH_3$ (cf. ref. 2). For the hydrocarbon, Stodola and Anderson favour the formula $C_{34}H_{70}$.

(1-methyl) are from Piper *et al.*[6]). The 2-methyl compounds melt at much higher temperatures than phthiocerane, and also differ in thermal behaviour and crystal structure (crystallize when pure only in tilted forms). The 3-, 4-, and 5-methyl substituted hydrocarbons, on the other hand, crystallize from acetone like phthiocerane with vertical chains, and also behave similarly on melting and solidification.

The long spacing of phthiocerane (46·3 A.) is the same as that of 4-methyltritriacontane (46·3 A.). Moreover, it is evident from Fig. 1 that the melting point of this hydrocarbon is close to that of phthiocerane. The *hk*0 reflexions observed for the synthetic hydrocarbons and phthiocerane agree closely with the corresponding strongest reflexions (that is, 110, 200, 210, 020, 310, 220) given by the vertical (*A*) form of normal chain hydrocarbons[7,8], both as regards spacings and relative intensities. The long spacing of 46·3 A. is nearly the same as that given by *n*-pentatriacontane (46·64 A., cf. ref. 8), which has two carbon atoms more in the long chain, and the main effect of the methyl side-chain in the branched-chain hydrocarbons is thus an expansion of the unit cell in the *c* direction. (The X-ray data on the synthetic hydrocarbons explain the previous interpretation of the X-ray diffraction pattern of an impure specimen of phthiocerane as being due to a normal chain[9].)

Although the data just given point to a 4-methyl substituted structure for phthiocerane, the physical properties of the hydrocarbons are such that other possibilities (mixtures) cannot be excluded on thermal and X-ray data alone (comparatively few orders of the long spacings are observed).

An infra-red investigation has therefore been carried out at Cambridge. The spectra of certain of the synthetic hydrocarbons with methyl groups in position 2-, 3-, 4- and 5- and of phthiocerane (a sample weighing about 8 mgm. was available) have been determined accurately between 700 and 1,400 cm.$^{-1}$ in solution in carbon disulphide. We find that the spectrum of phthiocerane is identical with that of 4-methyltritriacontane and 4-methyltetratriacontane, but differs markedly from those of the 2-, 3- and 5-methyl substituted compounds. The spectra are given in Fig. 2, with the exception of 2-methyltetratriacontane, which is not reproduced, since the 2-position for the methyl group is excluded on other grounds. It should be mentioned, however, that the spectrum of 2-methyltetratriacontane is quite different from any of the spectra in Fig. 2. It will be observed that the position of the methyl group has a very distinctive influence on the spectrum of these long-chain hydrocarbons, but that the spectrum is insensitive to a variation of one unit in the length of the main chain. The spectroscopic evidence for the correctness of a 4-methyl substituted structure for phthiocerane appears to be quite conclusive.

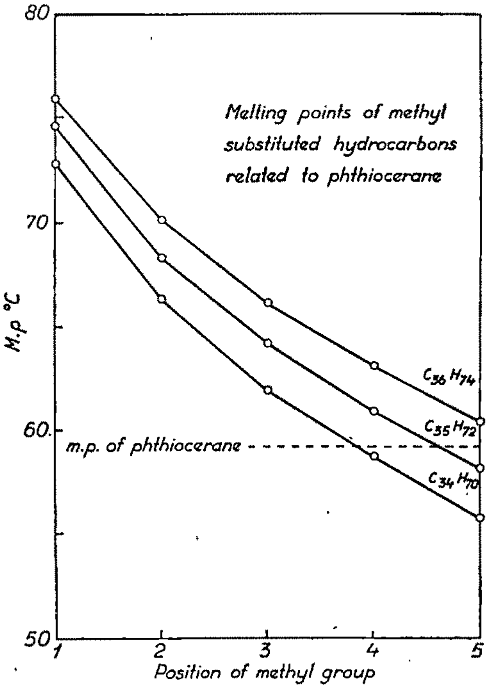

Fig. 1

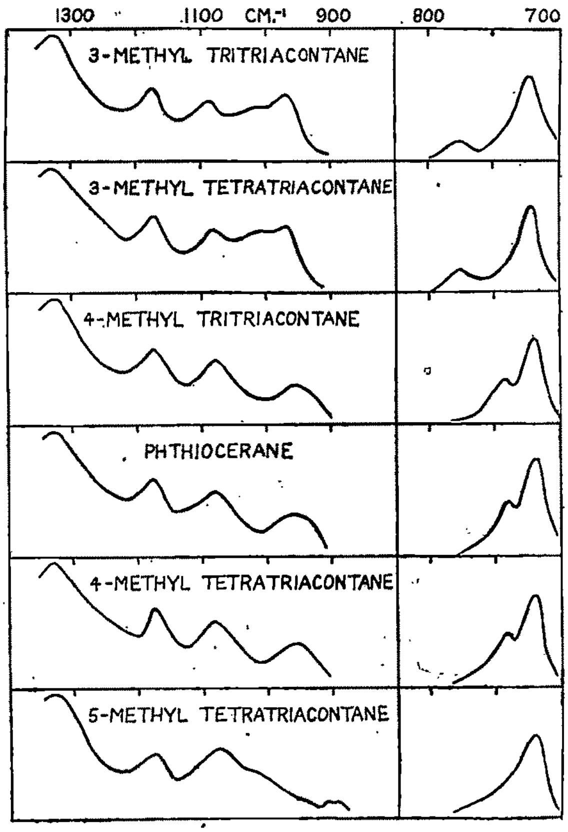

Fig. 2. INFRA-RED SPECTRA OF PHTHIOCERANE AND RELATED METHYL SUBSTITUTED HYDROCARBONS IN SOLUTION IN CARBON DISULPHIDE. 1,400–850 CM.$^{-1}$ (25 PER CENT SOLUTION); 800–700 CM.$^{-1}$ (6 PER CENT SOLUTION)

We should add, however, that apart from the empirical comparison of spectra, there is independent spectroscopic evidence that phthiocerane contains a methyl group in the 4-position. From extensive work done on hydrocarbons, at Oxford and Cambridge during the War, it is known[10] that long-chain paraffins having a methyl group in the 4-position always have a strong characteristic band at 740 cm.$^{-1}$. It will be noticed that such a band is present in phthiocerane; and the presence of this characteristic band provided strong, though not conclusive, evidence that phthiocerane has a methyl group in the 4-position. It is perhaps worth mentioning that the amount of material required for the final confirmatory run was just over 1·0 mgm. We have directed particular attention to these last points, since it seems quite probable that infra-red spectroscopy will have further interesting applications to problems of this type.

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FURTHER OBSERVATIONS ON THE NUTRITIONAL REQUIREMENTS OF THE LARVA OF *AEDES ÆGYPTI* L.

By Dr. L. GOLBERG and Dr. B. De MEILLON

South African Institute for Medical Research, Johannesburg

THE mosquito larva, by virtue of its short life-cycle, as well as the ease and convenience with which its growth may be studied under aseptic conditions, lends itself to biochemical investigation. A survey of its nutritional requirements is of interest from the point of view of comparative biochemistry. The brief account which follows serves to illustrate some points of resemblance which the larva bears to the chick on one hand and to lower forms on the other.

'Folic acid.' We have previously reported[1] that Williams's 'folic acid' preparation, supplementing a medium composed of salts, vitamins and water-extracted yeast residue, can produce complete pupation and emergence of mosquito larvæ. In such media 'folic acid' may be replaced by synthetic *L. casei* liver factor (pteroylglutamic acid)[2] or by *L. casei* fermentation factor[3]. Attempts to substitute for the yeast residue a mixture of lipoids and a pure protein revealed that 'folic acid' still had some effect; but that pteroylglutamic acid was inactive, the larvæ dying in the fourth instar. There would thus appear to be some factor or factors in the yeast residue which are necessary adjuvants of pteroylglutamic acid in larval nutrition.

Of the substances tested for their ability to supplement pteroylglutamic acid in this way, the lactone of 4-pyridoxic acid proved effective and so to a lesser extent did the lactone of 5-pyridoxic acid. In general, the results bear a striking resemblance to those of Scott, Norris and Heuser[4] in the case of the chick. Even with pteroylglutamic acid and the lactone of 4-pyridoxic acid the rate of growth, as measured by the time spent in each stage of development, was still considerably slower than in the presence of yeast residue. For this reason studies on fat and protein requirements necessitated the use of yeast autolysate as a source of 'folic acid'.

Lipoid requirements. The fact that dietary lipoid is not required by the growing larva is in keeping with the mass of observations establishing the synthesis of fats by insects from dietary carbohydrate and protein[5]. In the absence of lipoids from the diet, however, most fully grown mosquito larvæ do not pupate. Of the pupæ formed, the majority fail to emerge as adults. Thus the effect of fat in the larval diet manifests itself principally during metamorphosis, and this specialized function is correlated with the need for special types of fat. The common saturated and unsaturated fatty acids and triglycerides are quite without effect. Active compounds capable of satisfying, at any rate to a considerable extent, the particular needs of the larva for pupation and emergence, include cholesterol and related sterols, but also highly purified lecithin in which sterols could not be detected. Some degree of activity is manifested by unrelated compounds such as β-carotene and kerasin. Many other similar compounds, including some sterols, steroid hormones and phospholipides show little or no activity.

In all these cases the lipoids were 'dried' on the solid (kaolin or powdered cellulose) from a suitable solvent. However, when lecithin was tested in solution in the liquid part of the medium, the lipoid effect could not be elicited. It is to be noted, too, that the best results were obtained by using a mixture of cholesterol, lecithin and cephalin (1 : 2 : 1) in the solid state.

Table 1. Steroids capable of bringing about pupation and emergence of mosquito larvæ

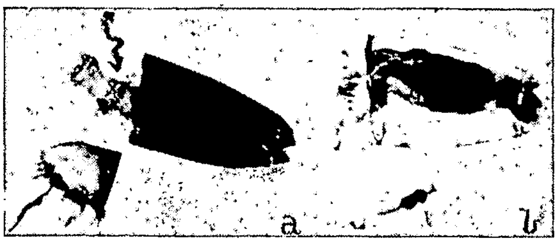
Active :	*Inactive :*
cholesterol and its esters	calciferol
sitosterol	all steroid hormones and related compounds of the pregnane, androstane, and œstrane series
Weakly active :	cholesteryl chloride
ergosterol	Δ^4-cholestenone* and its enol acetate*
stigmasterol (acetate)	α-7-hydroxy- and 7-ketocholesterols
coprosterol	$\Delta^{4,6}$-3-ketocholestadiene*
Active only in presence of yeast residue factor :	$\Delta^{3,5}$-7-ketocholestadiene*
zymosterol	3(β), 5, 6(*trans*)-trihydroxycholestane
β-cholestanol	*cis*- and *trans*-Δ^5-cholestene-3,4-diols and their diacetates
cholesterol dibromide	methyl Δ^5-3-acetoxy*bisnor*cholenate
7-dehydrocholesterol†	
Δ^4-3(β),6-dihydroxycholestene	
3(β)-hydroxy-6-ketocholestane	

* Growth-inhibitory. † Purity uncertain.

In the case of steroids it was found that apparently inert compounds could be made effective by the inclusion in the medium of a non-lipoid factor present in yeast residue but not in yeast autolysate. In the absence of this factor even the active sterols such as cholesterol do not produce optimum growth and survival of the larvæ. Bearing this fact in mind, a study may be made of the sterol derivatives capable of replacing cholesterol in the diet of the mosquito larva (Table 1). The results are to some extent in keeping with the findings of Fraenkel and Blewett[6] on other insect larvæ, and correspond remarkably closely with the observations of Cailleau[7] on the availability of sterols for *Trichomonas columbæ*. It is of interest to note that, of the cholesterol transformation products which Haslewood[8] has listed as likely to occur in normal cells during life, only two, Δ^4-3,6-dihydroxycholestene and 3-hydroxy-6-ketocholestane, are able to fulfil the larval need for lipoid. Moreover, both compounds are capable of exercising their effect only in the presence of the yeast factor to which we referred above.

Amino-acid requirements. The time taken by the first instar larva to reach the adult stage is an elastic quantity, ranging from 7·5 days to well over 30 days and depending almost entirely on the degree of adequacy of the medium. Nowhere was this elasticity more strikingly displayed than in experiments on the amino-acid requirements of the larva. With no added protein in the medium, growth does not proceed even to the second instar. Casein, particularly when in solution as sodium caseinate (1 per cent), could be used with lipoids and yeast autolysate to produce very good growth. Mixtures of nineteen and seventeen amino-acids were almost as effective as casein. The omission of dispensable amino-acids led to mixtures of from fourteen to eleven amino-acids, resulting in poor growth. Only a slight improvement could be brought about by varying the relative proportions of amino-acids present.

By omitting the amino-acids one at a time from the mixture of seventeen previously employed, the following were found to be indispensable for the growth of the larva: glycine, *l*-leucine, *dl*-*iso*leucine, *l*-histidine, *l*-arginine, *l*-lysine, *l*-tryptophane, *dl*-threonine, *dl*-phenylalanine, and *dl*-methionine. The status of *dl*-valine could not be determined while using yeast autolysate in the medium, since the autolysate was found to contain appreciable amounts of valine. 'Folic acid' could not be substituted for autolysate in amino-acid studies because no growth resulted, even when all other known growth requirements were satisfied.



SIPHON AND SADDLE OF (*a*) NORMALLY PIGMENTED FOURTH-STAGE LARVA; AND (*b*) UNPIGMENTED FOURTH-STAGE LARVA

The severity of the effect of deficiency of an essential amino-acid varied, but in the absence of each of several amino-acids no growth whatever could be observed. Perhaps the most interesting observation made in these studies was the effect of a medium deficient in phenylalanine or tyrosine. In the absence of added phenylalanine or tyrosine no growth takes place. With suboptimal amounts, the larvæ seem normal in every respect except that they appear to be wholly unpigmented. The accompanying photographs of the siphon and saddle of a normally pigmented fourth-stage larva and of the same area in an unpigmented larva serve to illustrate the ghost-like appearance of the latter. The pupæ, too, are lacking in pigment, but the adults which emerge are fully and characteristically pigmented. Two types of intermediate pigmentation were observed: in the first, black pigment begins to appear only in the fourth-instar larva; in the second, the use of substances analogous to tyrosine produced intermediate shades of pigmentation (Table 2). Both effects may be interpreted on the basis of the observation of Serra[9] that the diversity of colours of the melanins extracted from hairs of different hues results from the combination of varying proportions of melanoid pigment and protein. Lack of pigmentation does not appear to affect the rate of growth or survival.

TABLE 2. PIGMENTATION OF MOSQUITO LARVÆ IN A MEDIUM COMPOSED OF 0·5 PER CENT GELATINE, SUPPLEMENTARY AMINO-ACIDS (NO PHENYLALANINE OR TYROSINE) AND YEAST AUTOLYSATE

Compound tested	Concentration (gm. per l.)	Degree of pigmentation*
basal medium only	—	—
dl-phenylalanine	0·4	0
dl-phenylalanine	1·0	+ +
l-tyrosine	0·4	+ +
l-3-aminotyrosine	0·4	00
l-3,4-dihydroxyphenylalanine†	0·4	—
tyramine hydrochloride	0·4	0
dl-α-aminophenylacetic acid	0·4	0
p-aminophenylacetic acid	0·4	00 to +

* The significance of the symbols used is as follows:

—, white; no yellow pigment visible.
0, siphon and saddle clear yellow; no darkening.
00, siphon and saddle bright yellow; no darkening.
+, slight darkening of siphon and saddle.
+ +, siphon definitely darkened; saddle with a large clearly marked dark area dorsally.

† In this instance third-stage larvæ were examined. In all other cases fourth-stage pelts were used to assess the degree of pigmentation.

Despite the presence of large amounts of *dl*-methionine in the medium (up to 1·0 gm. per l.), the omission of the relatively small quantity of *l*-cystine customarily used (20 mgm. per l.) has an effect on the emergence of adult mosquitoes. The majority of the adults formed from the pupæ are found dead in the medium with only the upper half of the body projecting from the pupal case. Examination of the adults failed to reveal any obvious malformations. The same effect was occasionally observed in other amino-acid media, but was particularly prominent in the absence of added cystine. Cystine could be replaced by glutathione, but not by *dl*-homocystine.

The detailed findings, of which only the more salient features have been summarized above, will be published later, and full acknowledgment made to those who so kindly provided a number of the materials used in this work. Here we should like to thank Miss M. Currie and Mr. J. M. Thorp for technical assistance, and Mr. F. A. Brandt for the photographs.

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BACTERIOLOGY OF WATER

DIFFERENT problems involving micro-organisms in fresh water and the importance of fundamental and co-operative research in this field were considered at a symposium on water bacteriology which was held at the University of Reading on July 10, as part of the programme of the annual general meeting of the Society for Applied Bacteriology.

Dr. F. Greenshields (Metropolitan Water Board) presented a paper concerned with water-supply biology, in which he pointed out that pollution of lowland rivers in Britain in recent decades with drainage from arable land, and with sewage and trade-waste effluents, is accelerating the biological maturation of downstream reservoirs. The production of dense crops of phytoplankton, leading to excessive clogging of the filters or to the production of objectionable tastes and odours, makes it increasingly difficult to make stored water available to the consumer at certain seasons. The application of algicides to established growths is of palliative value only, and utilization of other methods of scientific control is hampered by ignorance of fundamental knowledge of growth requirements of different organisms. The increasing spread of limnological knowledge through the medium of the Freshwater Biological Association, and the contributions of the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research to the improvement in purification of sewage and trade wastes, should go far to achieve ultimate success in the effective control of algal growths.

Discussion of the paper was directed to the generally unsatisfactory procedure of chlorinating sewage effluents, which is not a feature in Great Britain, rather than endeavouring to obtain a more highly purified effluent; chlorination leaves the biochemical demand unsatisfied, and in the presence of gas works liquors may lead to production of cyanogen chloride —a substance of considerable toxicity to fish. It was considered that the construction of small-scale experimental reservoirs to follow up laboratory experiments is not so desirable as the use of reservoirs already established.

Difficulties which arise in assessing water quality from laboratory tests when coliform and pathogenic intestinal organisms develop outside their normal habitats were considered in a paper by Dr. E. Windle Taylor (Metropolitan Water Board) read by Mr. Burman. In the early days of the Second World War, it was found that efficient disinfection of water-mains after repair was sometimes difficult to achieve, and many investigations were undertaken to improve methods of repair and disinfection of mains. It was found that notwithstanding the greatest care that was taken in making a clean and hygienic repair and in the disinfection with chlorine, the raw jute yarn jointing material could itself be a source of subsequent contamination with micro-organisms. All types of coliform organisms, including *Bact. coli* type I, have been isolated, and it has been shown that some pathogenic intestinal organisms can also thrive on the yarn.

Laboratory experiments have confirmed the experience with samples collected in the distribution system that there are critical temperatures at which these coliform organisms can thrive. At the winter temperature of 4° C. and thereabouts, yarn is not a factor in the contamination of mains, but above 10° C. coliform organisms multiply actively in the yarn material. One lactose-fermenting organism having the reactions of *Bact. aerogenes,* except that it is capable of growing at 44° C., seems particularly associated with yarn and decaying wood, and on account of its frequent origin it has been christened the 'yarn' organism. Yarn in contact with water will form a breeding ground for pathogenic intestinal bacteria, and the ordinary chloramine residuals remaining in the water would have no disinfectant action. Researches have been undertaken into improving methods of chlorination of mains and into methods of sterilizing and treating joint-packing and also to find substitutes for it.

The paper led to spirited discussion on the specificity of the test involving the ability of *Bact. coli* type I to ferment lactose in MacConkey broth at 44° C., and the value of the test in view of the ability of the 'yarn' organism to carry out a similar reaction. It was suggested that if the indole test were used in conjunction with the 44° C. test it would be possible to distinguish between *coli* and *aerogenes* types growing at this temperature. In answer to a question, it was stated that jute was used as a packing material due to its cheapness and availability.

Some of the results obtained during a bacteriological survey of the Warwickshire Avon by the Water Pollution Research Laboratory in 1945–46 were given by Dr. C. L. Hannay and Irene L. Norton. In view of the fact that the bacterial flora of river water is pre-eminently Gram-negative, it was thought that interesting information might be obtained from counts in the river water of a Gram-positive organism the normal habitat of which is fæcal material. Consequently a study was made of fæcal streptococci isolated by means of a buffered glucose broth containing sodium azide. Results of the investigation, which included observations on the effect of sodium azide, showed that the proportion of streptococci isolated from river water which fermented mannitol was very similar to that found elsewhere for streptococci isolated from fæces. No streptococci with characteristics of either *Strep. lactis* or *Strep. bovis* were isolated, and it was considered that although the medium appeared to be specific for streptococci of Group *D*, ultimate specificity rests on serological grouping.

The paper evoked considerable discussion chiefly concerning the efficiency of the medium and method employed. It was considered by the authors that it is unlikely that at high dilution the streptococcal chains are disrupted, for replicate counts gave results in good agreement. Although no data had been obtained, it was considered that the survival-rates of various fæcal streptococci and coliform bacteria in river water are probably very different.

The seriousness of infection of imperfectly sealed cans of food due to contamination with cooling water of high bacterial count was discussed by Mr. T. E. Bashford (The Metal Box Co., Ltd.) in a paper entitled "Infected Cooling Water and its Effect on the Spoilage of Canned Foods". Due to methods of manufacture, it is not always possible to have cans with perfect seals, some minute channels being left unsealed. Laboratory experiments showed that the incidence of infection of the cans is greatly affected by the numbers of bacteria in the cooling water. As many canneries are situated in rural districts where the supply of water of low bacterial count is not always available, some method of sterilization should be employed, and tests had shown that chlorination is a suitable method. Dosages of chlorine to the cooling water allowing a chlorine residual of 1–2 p.p.m. and a contact time of 20–30 min., were found effective in reducing appreciably the numbers of infected cans, but subsequent contamination during distribution of faulty cans is always possible. It was suggested during discussion that more effective sealing compounds are required, and that possibly some rubber emulsion containing an antibiotic might be satisfactory in preventing contamination of the can and spoilage of the contents.

Dr. C. B. Taylor, in a paper entitled "Some Aspects of the Bacteriology of Lakes and Streams", pointed out the paradox that water bacteriology of the text-books is largely concerned with studies of organisms which have a normal habitat other than water, and that the Freshwater Biological Association is concerned primarily with fundamental studies of bacteria capable of multiplying in the waters of streams and lakes and in the deposits beneath. Preliminary work already carried out has shown that the distribution of bacteria in lake waters, estimated by plate counts, is largely dependent on water movements, which at times are extremely complex and vary rapidly with changing atmospheric conditions. In order to obtain a properly balanced consideration of 'water bacteriology' future work must involve studies of bacteria in (*a*) the water, (*b*) associated with the plankton, and (*c*) in the deposits. Work is in progress in connexion with the factors which limit growth of bacteria in lake waters, and it is hoped that the results will serve as an introduction to a more specialized study of the nutrition of water bacteria. As Algæ are the primary producers of organic matter in a large body of water, their association with bacteria in life and during decay is of considerable importance; present work, which has demonstrated that bacteria living on dying cells of the diatom *Asterionella* are unable to grow on common solid laboratory media, indicates the technical difficulties involved in such studies. Preliminary studies on lake muds has shown that in large bodies of water such autotrophic processes as involve nitrogen and sulphur oxidation are confined largely to the immediate surface layer of the deposits. In the discussion following the paper several speakers emphasized the need for developing work on the bacteriology of water along these lines.

C. B. TAYLOR

PRACTICAL TRAINING OF ELECTRICAL ENGINEERS

THE practical training of the professional electrical engineer is the subject of a report published recently by the Institution of Electrical Engineers*. The report, which is the work of a joint committee comprising representatives of the Institution, the Radio Industry Council and the British Electrical and Allied Manufacturers' Association, makes specific recommendations as to the character and duration of an ordered scheme of practical training, and reviews in some detail various considerations underlying its recommendations.

Where the young engineer has obtained his academic qualification by a full-time university course, the practical training should occupy two years and be termed a 'graduate apprenticeship'. Where, on the other hand, part-time technical education of appropriate standard is being pursued during the industrial apprenticeship, the duration of the practical training should be four years. This is termed a 'student apprenticeship'. Subdivision of the training period is made under three headings: basic mechanical training; basic electrical training; and office training. The first period, occupying roughly half the total time, deals with general manufacturing methods and workshop processes. It is in the second period that attention is directed towards the more specifically electrical aspects of the manufacture of particular types of electrical machinery or apparatus. The title "Office Training" is used to cover the acquisition of experience in the drawing office, planning and progress departments.

During the student apprenticeship it is assumed that the apprentice will be released from work on one day a week to attend a technical college course leading normally to a Higher National Certificate.

Stress is laid upon the value of the personal contacts which the apprentice makes with all classes of industrial personnel during his training period. It is largely through these contacts that he develops his sense of personal responsibility and his appreciation of the great importance of human relationships in industry. In the same connexion, mention is made of the merits of apprentice associations and similar bodies.

While the general plan developed in this report is based upon conditions obtaining in a relatively large manufacturing organisation, the special considerations affecting smaller firms and those specific to the operating side of the industry have also been given detailed attention. It is laid down as axiomatic that practical acquaintance with the basic processes employed in manufacture is needed by every engineer. For organisations such as electricity supply undertakings or telecommunication services, provision is therefore made for a considerable period of 'secondment' of the apprentice to a manufacturing organisation.

Quite apart from its specific recommendations, the report embodies a most careful analysis and appraisal of the duties and functions of the professional engineer and of the purposes towards which the various departments of his practical training should be directed. The report does not make specific reference to the important and difficult question of how best to integrate the military service requirement into the training period. It should be mentioned, however, that provision has been made by the Ministry of Labour and National Service for deferment to cover the whole of a five-year period of technical education and practical training. The details of this provision, which are set out in a leaflet, N.L.11, issued by the Ministry, are restated in the June issue of the *Journal of the Institution of Electrical Engineers* and are the subject of a further comment in the September issue of the *Journal*.

FORTHCOMING EVENTS

Monday, October 27

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Standardization in the Electrical Industry" (to be opened by the President, Mr. P. Good).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. B. Gordon Darnton: "Incidentals in Latex Treatment".

Tuesday, October 28

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "The Vegetation of the Chalk", 1. "The Characteristics of the Chalk Habitat and the Chemical and Physical Factors of the Environment".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Mr. R. B. Heywood: "Photoelasticity Applied to Design Problems".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. O. V. Vick, Mr. C. Lamond and Mr. W. Lindsay: "The Organisation of an Instrument Department in an Industrial Works".

Wednesday, October 29

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. L. Adam: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. A. Haddow and Dr. L. A. Elson: "Food and Cancer".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at Woolwich Polytechnic, Woolwich, London, S.E.18), at 7 p.m.—Mr. J. G. N. Gaskin: "The Examination of Questioned Documents".

Thursday, October 30

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Rev. Prof. C. E. Raven: "Early Records of British Plants with special reference to Thomas Lawson (1630–91)"; Dr. W. S. Bristowe: "Notes on the Habits and Prey of Twenty Species of British Hunting Wasps".

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* The Practical Training of Professional Electrical Engineers. Report of a Committee appointed by the Council of the British Electrical and Allied Manufacturers' Association, the Radio Industry Council, and the Council of the Institution of Electrical Engineers. Pp. 42. (London: Inst. Elect. Eng., 1947.) 1s.

Royal College of Surgeons of England (at Lincoln's Inn Fields, London, W.C.2), at 5 p.m.—Dr. James Craigie: "Viruses, Self-reproducing Substances and Tumours" (Imperial Cancer Research Fund Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. E. Orowan, F.R.S.: "Strength and Plasticity of Solids". (Further lectures on November 6 and 13.)

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. James Bain: Third British Commonwealth and Empire Lecture.

Royal Statistical Society, Sheffield Group of the Industrial Applications Section (in Room B 1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield), at 6.30 p.m.—Mr. P. Lyle: "The Application of Regression Analysis to Industrial Problems".

Royal Institute of Chemistry, Manchester and District Section (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. A. J. Curtin Cosbie: "Beer".

Pharmaceutical Society, Manchester, Salford and District Branch (joint meeting with the Guild of Public Pharmacists, in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7.45 p.m.—Dr. R. Forgan: "British Contribution to Tropical Medicine".

Friday, October 31

Biochemical Society (at St. Thomas's Hospital Medical School, London, S.E.1), at 2.15 p.m.—Scientific Papers.

Physical Society (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. D. G. Avery and Mr. R. Witty: "Diffusion Pumps, a Critical Discussion of Existing Theories"; Mr. J. Skrebowski: "Electron Diffraction from Anthracene, with Special Reference to the Diffuse Background".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. T. A. Kestell: Discussion on "The Manufacture of Turbine Blades for the Whittle Engine".

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. T. W. F. Brown: "A Marine Turbine Research and Testing Station" (Andrew Laing Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Rt. Hon. the Earl De La Warr: "Problems Facing British Agriculture".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Officer to take responsibility for and continuous charge of the execution of a project of research into social mobility and social class, under the direction of Mr. D. Caradog Jones—The Secretary, London School of Economics, Houghton Street, Aldwych, London, W.C.2 (October 30).

Lecturer in Biochemistry in University College, Dundee—The Secretary, The University, St. Andrews (October 31).

Assistant in the Department of Chemistry—The Secretary, The University, Aberdeen (October 31).

Teachers of (*a*) Engineering Drawing, Mathematics, Engineering Science, for Ordinary National Certificate and City and Guilds courses; (*b*) Engineering Subjects up to Higher National Certificate standard in Production Engineering; (*c*) Engineering Subjects up to Ordinary National Certificate standard in Electrical Engineering; (*d*) Chemistry, Physics, Mathematics, up to Ordinary National Certificate standard in Metallurgy—The Principal, Wandsworth Technical Institute, Wandsworth High Street, London, S.W.18 (October 31).

Lecturer to teach Physics to Intermediate and possibly B.Sc. standard, together with some Mathematics, at the Plymouth and Devonport Technical College—The Director of Education, Cobourg Street, Plymouth (November 1).

Lecturer in Biochemistry—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9 (November 1).

Assistant Lecturer in Physics—The Registrar, University College of Wales, Aberystwyth (November 1).

Graduate Lecturer in Mathematics and Science, either Chemistry or Physics—The Principal, Dudley and Staffordshire Technical College, Dudley (November 1).

Teacher (Graduate or equivalent) of Mechanical Engineering Subjects up to the standard of Ordinary National Certificate—The Principal, Technical Institute, Killigrew Road, Falmouth (November 1).

Assistant Master (with a good degree in Science) to teach Chemistry, with Physics and Mathematics as additional subjects, at the Ashington Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne 1 (November 1).

Teachers in (*a*) Mechanical Engineering, (*b*) Production Engineering, (*c*) General Science Subjects, (*d*) Automobile Engineering, at the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick (November 1).

Lecturer in Mathematics and Science in the Building Department—The Principal, Guildford County Technical College, Stoke Park, Guildford (November 1).

Assistant Lecturer in the Mining Department of the Castleford, Whitwood, Mining and Technical College—The Divisional Education Officer, 85a Carlton Street, Castleford, Yorks (November 1).

Agricultural Economists and Assistant Agricultural Economists in the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2023 (November 6).

Teacher of Botany and Zoology for day and evening classes—The Principal, Norwood Technical Institute, Knight's Hill, London, S.E.27 (November 8).

Honours Graduate in Mathematics at the South-West Essex County Technical School, Walthamstow—The Borough Education Officer, Town Hall, Forest Road, Walthamstow, London, E.17 (November 8).

Agricultural Lecturer to the Shropshire Education Committee—The Secretary for Education, County Buildings, Shrewsbury (November 8).

Horticulturist in the Department of Agriculture, New Zealand Government—The Office of the High Commissioner for New Zealand 415 Strand, London, W.C.2 (November 10).

Lecturer in the Departments of Social Studies and Extra-Mural Studies—The Registrar, The University, Leeds 2 (November 10).

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Statistician in the General Register Office—The Secretary, Civi Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2013 (November 15).

Chair of Sociology, and Research Posts (2), in Natal University College, Durban—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (November 24).

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Medical Statistician in the General Register Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1 quoting No. 2015 (November 29).

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INCENTIVES IN INDUSTRY

HOWEVER true it may have been in the past that men of science tended to disregard the intangible human element in a situation and to concentrate almost exclusively on the physical factors which they could measure, that charge could not be levelled against those who met at Dundee to take part in discussions at the British Association meeting which touched on the economic situation confronting the nation. The measures which could be adopted to increase productivity and to utilize more effectively the resources of the United Kingdom, and the contribution which science could make to that end, were never considered merely from the purely material or physical point of view. The human factor was given its full weight, and even industrial or productive efficiency was estimated not solely from the mechanical aspect but also in the light of the physiological and psychological demands which were involved in the effort required from men and women.

That was, of course, particularly true of discussions in Sections I (Physiology) and J (Psychology), but it also characterized some of the general discussions as well as various joint discussions of general interest such as those on "Man and the Machine", on selection for management and on incentives in industry. In all these there was manifest more awareness of the outlook and needs of ordinary men and women than has been apparent in some of the recent manifestations of Government policy to deal with the present situation. A striking example is to be found in Dr. R. E. Lane's fine contribution to the discussion on man and the machine, which showed a clear conception of what is involved and needed in the sphere of human relations in industry whatever form of organisation may be adopted. Nationalization alone, as the brief experience of the National Coal Board is already tending to show, is no sufficient solution, and no economic and financial system of incentives can dispense with the need for further work in this field of human relations. All possible means must be taken to eliminate the suspicions and misunderstandings which have hindered co-operation in the past, and to promote both an atmosphere and an outlook which make for co-operation and mutual confidence.

That is the first condition of increased productivity, and the symposium on incentives in industry arranged by Sections F (Economics) and J (Psychology) on September 2 demonstrated the crucial importance of such personal satisfactions. Dr. J. A. Bowie, in opening this discussion, urged that the psychological conditions are even more important than the physical ones. Incentives as commonly conceived may even offer no real contribution in the battle for output, and he thought it possible that no system of incentives would work well or permanently within the limits of the present system. What is needed is a sense of participation, which may only be secured by radical changes in factory life dispelling the present misunderstandings and distrust. A new psycho-sociological approach and further research in the field of incentives might make most important contributions in securing the satisfaction in work and sense of participation which would provide the real remedy for so much industrial unrest and low productivity.

Much the same point of view was urged by Mrs. W. Raphael, of the National Institute of Industrial Psychology, from the results of attitude surveys covering 15,000 workers of all grades in industry, conducted by the staff of the Institute in recent years. Financial incentives are not all-important, although they may be very significant if the workers do not consider their pay to be 'reasonable' or 'fair'. Satisfaction in the job itself is important among managerial and skilled workers, but less often in skilled and unskilled work, and can be increased by good vocational guidance, selection and training for the job. Participation, the sense of mattering to the organisation, and knowing about and possibly influencing its activities are important incentives which should be stimulated by such methods as joint consultation in its widest sense.

The National Institute of Industrial Psychology has obviously experience which could be of great value to the numerous joint production committees and to other bodies concerned with joint consultation as well as to management, including those organisations supporting research in the management field. That experience will no doubt be fully available to the British Institute of Management; and a body such as the National Staff Administrative College may well be expected to assist in the wider and wiser study and use of incentives throughout industry. Mr. Dennis Chapman's review of the factors that make for harmonious relations between working groups indicated other fields for research. Like Mrs. Raphael, he directed attention to the importance of environment, while Mr. C. Madge, of "Mass Observation", again emphasized that financial incentives are only one factor in a complex situation. Payment by results and bonus systems are only really successful when applied by managements who recognize this limitation. Few people work as hard as they are physically capable of doing, and restriction of output may be both conscious and unconscious, originating sometimes in the fear of unemployment through over-production. Moreover, there are demands for leisure, for less responsibility and for easier work, which can be as real and potent as the demand for material goods.

Mr. Madge urged that the principal way to increase production is by improvements in machines and in the physical organisation of the factory; but it is easy to see how, at a time when the worker finds it difficult to exchange wages or salaries for the material goods he desires, the pulling power of the demand for leisure and easier work can easily become more potent, even if we leave out of account the effect of six years of war. The balance will most certainly not be redressed by exhortation and organisation alone. As regards the building industry, which is among the least progressive and most wasteful of British industries, neglectful of research and indifferent to innovation, the scale of values of the operatives differs in important respects from that of many other industrial workers. To most of them a steady guaranteed wage is more important than higher but less regular earnings obtained either through a rise in rates or through payment by results. Most of them, too, are unwilling to accept increased payment under a system which, in their view, would inhibit or destroy other strong motives such as pride in craftsmanship and the sense of comradeship. Miss N. M. Davis's contribution dealing with this industry was of special interest.

It is clear that here as elsewhere the problem is really one of building co-operation into our whole industrial system, and in an industry such as the building industry this is the only means of achieving the immediate results that are imperative. Technical improvements resulting from research may make large contributions to increased efficiency in the long run, but for immediate results it is upon efficient management as well as a new approach to incentives, conditions of employment and welfare that we must rely.

There is, in fact, urgent need for a scientific approach to the problems of incentives and human relations, both in private and nationalized industry; and the need is the more imperative because whatever shortcomings may be urged against private industry, there is no evidence that industry directed by the State itself would be either more efficient or freer from labour disputes and unrest. The evidence so far indicates a conspicuous failure of the idea of the public interest and a concern for the welfare of the whole community to permeate the rank and file of the employees of nationalized industry. This, however, is our fundamental need, and until it is true of industry generally, whatever the form of its organisation, we are unlikely to see the full productive effort that is required.

A thoughtful paper on this point has been contributed by Dr. Ordway Teed on "Public-Mindedness through Co-operation" (*Ann. Amer. Acad. Pol. and Soc. Sci.*, Nov. 1946). Dr. Teed sees no quick and easy way to industrial peace, but he maintains firmly that collective bargaining as the beginning of responsible constitutional government in industry is the primary public interest. Equally, he insists that the pattern of joint management – labour working arrangements must be voluntary, and he develops his argument on similar lines to Colonel Urwick and Mr. C. C. Renold in Great Britain.

The conception of the common interest requires, however, the development of much more effective means of informing all parties of the reasons for decisions and policies, so as to secure their consent and support, and there is room for inquiry into the best means of achieving this. We cannot wisely assume that the production committee or works council is the only, or even the best, means of doing so. Moreover, when we have succeeded here, we may find that the whole order of importance of incentives is changed. We may, in fact, find that though the financial incentive needs to be supplemented by others, which it is the urgent duty of management to explore and apply, such as pride in the finished product and a knowledge of its value to the country, the possibilities of group leadership and competition, and the latent desire for self-expression, it may, subject to appropriate safeguards, afford the most effective and compelling motive of all.

One aspect, often forgotten, is well brought out in some of the inquiries already made; it is not for the monetary reward itself that the financial incentive is important, but for the satisfaction which that monetary reward makes possible. What needs to be remembered is that once the monetary reward is sufficient to meet elementary and basic human needs, it makes possible the satisfaction of other needs according to individual choice. It is partly because controls and shortages are preventing such satisfactions that the financial incentive has proved ineffective. But, however effective the service motive may become, no alternative to the financial incentive which offers the same opportunity and freedom of choice has yet been proposed.

Prof. H. S. Kirkcaldy's reminder to the planner, in his "Industrial Relations in Conditions of Full Employment" (Cambridge University Press, 1945), that the ultimate judge of essential liberties is the individual citizen or worker himself is equally pertinent in this matter of incentives, and in so far as the financial incentive permits the exercise of the freedom of choice it should not be discounted so severely as in the discussion at Dundee. The point is one that the Government, too, has widely disregarded. Incentives need to be tangible and easily visualized by the worker; when, as at present, Government policy has deliberately removed both the 'carrot' and the 'stick', it is not surprising that production lags.

The effort to build up co-operation effectively which, as Prof. Elton Mayo has remarked, is the fundamental problem we face to-day, must take full account of this aspect of freedom. It accentuates the importance of the question of the communication of knowledge and information; both the capacity of an individual to communicate his feelings and ideas to another, and that of groups to communicate effectively and intimately with each other. Much that was said at these discussions at the British Association's meeting at Dundee confirms the correctness of Prof. Mayo's view that social study should begin with careful observation in this very field. Here our civilization is most defective, and although we have reached some appreciation of the fact that collaboration in an industrial society cannot be left to chance, we have yet to realize that there is no simple or rapid solution. Patient, pedestrian study of the wholly neglected problem of the determinants of spontaneous participation is, as Prof. Mayo observes, the line of advance, and imperative as is the application of scientific method to the study of the social situations involved here and elsewhere in industry and in society, the scientific approach offers no promise of immediate solutions. The British Association discussions should not only lead to the more widespread study of these questions, but should also assist a more sober and realistic appreciation of what is involved and the conditions of success, and above all the importance of extending and developing both technical and also social skill and human co-operative capacities. It would be disastrous to rely entirely on the production committees and works councils without exploring this whole field of the techniques to determine the effects of action in the social field, the means of securing spontaneous co-operation alike of groups and of individuals. The problem of incentives is only one facet of the larger one of industrial relations, which in turn is, as we are now realizing, part of that of the relations between groups and individuals in the society which constitutes the whole nation. Objective inquiry there must be, and action and policy must increasingly be based on the results of such inquiry and the techniques developed thereby, at the level of Government, in the factory, the workshop and the laboratory. Ultimately it is the task of management to use that knowledge and technique to serve the common ends, and no amount of exhortation and precept can be a substitute for the effective leadership which is the mark of good management and also of good government.

NEWTON AS CIVIL SERVANT

Newton at the Mint

By Sir John Craig. Pp. viii+128+4 plates. (Cambridge: At the University Press, 1946.) 7*s*. 6*d*. net.

IN 1696, when he was fifty-three years of age, Newton was appointed warden of the Mint, and in 1699 he was promoted to the master's place, which he held to the date of his death. The last thirty-one years of his life were thus passed in a public service which, if not as a whole arduous, yet occupied much of his time and was, on occasion, vexatious and exacting. So much can be found in any biography, but hitherto there has been no detailed account of this aspect of the great man's life, nor, indeed, are the necessary sources within reach of all.

Sir John Craig, who now comes forward to fill the gap, is particularly fitted for the task, having himself long been deputy master of the Mint, where he has had access to most of Newton's writings on matters concerning coinage. He has already, with Prof. Shirras, examined Newton's monetary theories in the *Economic Journal* of June 1945, although without reference to certain papers now available to him. In the little book before us he explains the very complicated history of the coinage of Britain, in particular the recoinage round about the beginning of the eighteenth century; the structure and personnel of the Mint, including such matters as the respective duties of the warden and the master; the many technical problems of producing coin at the period in question and the fixing of the intrinsic value; and, in particular, Newton's part in it all.

The book is written from the point of view of one familiar not only with the manufacturing problems of coinage but also with the economics of metal currency and of foreign exchange, which makes it in parts tough reading for the cloistered physicist. All the more does it show that Newton was thoroughly competent in financial matters, of which he wrote with his usual incisiveness, as exemplified, for instance, by the following passage.

" 'Tis mere opinion that sets a value upon money; we value it because with it we can purchase all sorts of commodities, and the same opinion sets a like value upon paper security. . . . All the difference is that value of gold and silver is set upon their internal substance or matter and therefore is called intrinsic, and the value of paper security upon the apparent form of the writing and therefore called extrinsic, and that the value of the former is more universal than that of the latter."

He was also, it appears, a good organiser and, surprisingly enough, tactful and successful in his personal relations, but he was "averse from all novelties" and made no notable innovations. How different, in every respect, is his record as a Civil servant from his record as a man of science.

The Great Recoinage which began early in 1696 is usually represented as a national melioration, for which Newton was largely responsible. For example, Mr. George Roberts, one-time director of the United States Mint, says of it, "unquestionably it was a great reform, creditable to all who had any part in it". Alfred Marshall termed it "the necessary but drastic remedy, which the Government was applying in 1695 for the corrupt condition of the coinage". Sir John states bluntly that it was a social crime and, in any case, the principles had been determined before Newton's first appointment, so that he was only the agent for putting into practice decisions already reached. The difficulties with which he had to contend in this capacity, including the constant disputes between the garrison of the Tower, in which the Mint was situate, and the personnel of the Mint; the prosecution of coiners; and the trouble with the standards, described with many other concerns in a chapter entitled "All Kinds of Vexations", are clearly depicted. A matter of considerable general interest that occurred towards the end of Newton's life was the affair of "Wood's halfpence", still remembered from Swift's attacks in the "Drapier Letters". Apparently the coinage in question would have been better in all particulars than any issued before in Ireland, but in view of the unjustified, but violent, agitation against it, it was withdrawn. "The English Government had no inclination to do unpopular good by force." Newton's part in the whole affair was, of course, purely technical.

The student of Newton will find in this book many personal details of general interest. Typically enough, we find Newton, who was always a man of his hands, carrying out assays himself, no doubt to see how it was done, since, apparently, he made no improvements. Sir John concludes that Newton wrote at tremendous speed, which is consistent with his habit of perpetually redrafting, of which many examples are given. Anyone who has studied the catalogue of the Sotheby sale of Newton papers in 1936 will find no difficulty in accepting this conclusion. The author opines that these pains and scruples and afterthoughts in drafting may have fostered Newton's lifelong aversion from publication: perhaps we might rather say that the redrafting and the shrinking from publication were both symptoms of his horror of controversy, to which ambiguous passages might give rise. Not known to everybody is the fact, here recorded, that Newton changed the Royal Society meeting day from Wednesday to the present Thursday, because Wednesday was the Mint's day for paying out coin.

Enough has been said to make it clear that this is a book which everyone seriously interested in Newton must possess. It is embellished by many a pleasant turn of phrase, as when the author refers to Halifax's association with Catherine Barton as "a morganatic alliance without benefit of clergy", or when he says of a phrase in an Act "it must signify something, as an absurdity of Parliament was, legally, unthinkable, but each learned man favoured a different something". The general merit of the little work being fairly acknowledged, it will not, I trust, appear ungracious to point out a few minor deficiencies. The author would seem not to have consulted, or, at any rate, made full use of, either De Morgan or Edelston, and when he mentions the "famous report of 21 September 1717", which was long a weapon in the controversy between the bimetallists and the champions of the gold standard, he does not give the references where the ordinary reader can find it and other reports, namely, the "Macclesfield Correspondence" and "A Short Essay on Coin"; nor does he quote McCulloch's "Select Collection of Tracts on Money" or refer to Horton's "Silver Pound". In general, the references which the serious student needs are lacking. "Mr. Gyre's house" at Pudlicot should, according to the reprint of the letter in De Morgan, be "Mr. Ayre's house", which sounds more probable. To say of the prize of £20,000 for the longitude that "one half of this was won by John Harrison in 1726" is so manifold an error that one can only refer the reader to R. T. Gould's "The Marine Chronometer". The reference to Brewster in this matter is wrongly given. I doubt if the statement that Newton was knighted to attract voters can possibly be made good. But these are trifles, and we would wish to end on a note of thanks to Sir John for the learned labour which he has put into this informative little work. E. N. DA C. ANDRADE

GENETICS AND MAN

Genetics, Medicine and Man

By H. J. Muller, C. C. Little and Laurence H. Snyder. Pp. xi+158. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1947.) 2.25 dollars.

THIS book presents the subject-matter of the Messenger Lectures delivered in 1945 at Cornell University by three geneticists, each outstanding in his own particular field. The lectures were addressed to a general audience and dealt with (*a*) the fundamental principles of genetics (H. J. Muller), (*b*) parental influence and growth of individuality (C. C. Little) and (*c*) the special genetics of man (L. H. Snyder).

As was to be expected, Prof. Muller presents a most attractive account of genetical fact and theory, simple yet meticulously accurate in statement, clothed with pretty notions and bedecked with stimulating ideas. To him the dance of the genes is a spectacle to be seen and an entertainment to be enjoyed. He has a great facility for enabling an audience to share his pleasure. To know or to hear him is to appreciate the excitement of adventure that can be encountered in the genetical field and the quiet joy that comes with an understanding of its principles.

Dr. Little is another example of the relative importance of the apostle in the attraction of interest and attention to the science which he represents. Here is the picture of a man who turned away from the glamour and power of high positions of academic and political eminence to return to the quiet aloofness of a laboratory. The account which he gives of the discoveries made by himself and his colleagues in the Roscoe B. Jackson Memorial Laboratory at Bar Harbor reveals in the clearest possible fashion that the greatest gifts that science can give to a man are intellectual honesty of the highest order, an emotional serenity and a great faith in the expanding dignity of mankind.

Prof. Snyder is a recognized leader in the field of medical genetics, to which subject he himself has made many notable contributions. There is none better qualified than he to show the place of genetics in medicine, its importance in the search for etiological factors and its limitations. In this brief narrative he easily succeeds in displaying the role of the gene in the causation of human defect and derangement.

A course of such lectures by such men could not do otherwise than demonstrate in the clearest possible fashion the important bearing that genetic fact and theory have upon a wide diversity of human and social interests and activities.

This book will claim the attention of all geneticists, since all will wish to see how these three colleagues of theirs tackle the problem of making genetics attractive to the general audience and reader. It can be strongly recommended to practitioners of medicine and to men of science other than biological; in fact, to all who seek an easy yet strictly accurate account of what genetics has become and of what it can promise in application. F. A. E. CREW

THE PROCESS OF PUBERTY

Adolescent Sterility

A Study in the Comparative Physiology of the Infecundity of the Adolescent Organism in Mammals and Man. By Assoc. Prof. M. F. Ashley-Montagu. Pp. ix+148. (Springfield, Ill.: Charles C. Thomas; Toronto: Ryerson Press, 1946.) 3.50 dollars.

IN "Adolescent Sterility" Dr. Ashley-Montagu assembles an impressive body of facts which show that puberty in the female is not a sudden assumption of the capacity to reproduce, but a slow process of development during which the ovaries and the accessory reproductive organs develop their rhythm of physiological activity. Ovulation, and especially ovulation as a fairly regular phenomenon in the sexual cycle, is not established until the end of the pubertal phase. Consequently it follows that conception is unlikely to follow mating during a mammal's first sexual cycles, and that a period of what is called "adolescent sterility" is associated with the process of puberty. Dr. Ashley-Montagu defines the term as the interval of time from the first œstrus during which, in a given population, a majority of normally developing individuals are incapable of conceiving and remain sterile, while those which do conceive either suffer a high mortality-rate or exhibit a high proportion of abortions or miscarriages. This latter effect is attributed to the fact that at the time of the first ovulations the body "as a whole" may not have reached a mature enough state to sustain the process of reproduction.

Dr. Ashley-Montagu supports these generalities with experimental observations that have been made on mice, cows, rhesus monkeys and chimpanzees, and with a number of statistical observations about human reproduction in different parts of the globe. These show that the percentage sterility and the average interval between marriage and the birth of the first child are greater in women under than over the age of twenty, and that "prior to the age of 20 years the process of childbearing constitutes a hazard to the life of both mother and child, which increases in proportion to the youthfulness of the mother and decreases to a minimum at maturity".

Dr. Ashley-Montagu has personally contributed little to the body of evidence which he reviews, for he is an anthropologist, not a physiologist. His wide reading, however, has provided him with an extensive knowledge of a field not quite his own. Unfortunately it is also reflected in a laboured treatment of the subject, in excessive quotation, and in the discussion of topics which are somewhat remote from the main theme. This is a drawback in a short book; but students will no doubt willingly put up with this fault in return for the able summary which Dr. Ashley-Montagu provides. S. ZUCKERMAN

OCEANIC BIRDS: A PICTORIAL SURVEY

British Sea Birds

Written and illustrated by C. A. Gibson-Hill. Pp. 144 (48 plates). (London: H. F. and G. Witherby, Ltd., 1947.) 18s. net.

THE author selects twenty-four of the most oceanic of the sea-birds which breed in the British Isles, and makes them the subject of a series of thirteen short essays. There is nothing original about these essays—they are the result of a photographic tour made by the author in 1946 around the principal accessible islands and coast sites, and in one brief summer of bad weather the author makes no claim to having discovered any new facts. Yet he has managed to convey to the reader something of the charm of the islands and their avian inhabitants. He has drawn, with acknowledgments, upon the original observations published by other workers, including the recently published work of American ornithologists, who made progress denied to British observers during the war years. This information is presented in a straightforward style, and in a large type that is refreshingly easy to read. Line-drawings of the heads of related species showing seasonal plumage changes are quite useful, although some are redundant because the photographs show these differences more clearly. The elementary life-history of each bird is sketched out—breeding, feeding and migration, and a note added on the derivation of the common name.

Considering the high price of this book, and the interest that is taken in Britain in sea-birds, the text is disappointingly brief. Distribution and field characters and notes on rarer species are squeezed into a concluding chapter with distribution maps, but these are not as accurate as one could wish. The photographs, taken with a miniature camera, speak of the patience and skill of the author, and although they suffer somewhat from over-enlargement and from being grouped together without relation to the text, they are most attractive. One has the impression that the author set out to make a book of photographs of sea-birds, and decided afterwards to expand the captions into brief chapters. As an advertisement or pictorial introduction to the study of British sea-birds the book is of value to the beginner. R. M. LOCKLEY

The Cult of the Superman

A Study of the Idea of Heroism in Carlyle and Nietzsche, with Notes on other Hero-Worshippers of Modern Times. By Eric Bentley. Pp. xxiii + 277. (London: Robert Hale, Ltd., 1947.) 12*s.* 6*d.* net.

THIS is a discussion of the cult of the hero considered as the shaper of human destinies; a cult started by Carlyle, developed by Nietzsche and continued by Wagner, Bernard Shaw, Spengler, Stefan George and D. H. Lawrence. The last three, though Mr. Bentley does his best to polish them up, are just dim. Shaw, who is anything but dim, is only a hero-worshipper spasmodically in his Wagnerite moods. Wagner had great influence in his day, but still is only a lightweight. Were even the first two heavyweights? Mr. Bentley thinks they were or he would not have written this witty and provocative book. They have been labelled proto-fascists; but the label, even if it is appropriate, does not make their ideas negligible. Fascism takes account of elements in human nature which liberals and rationalists have refused to see. Carlyle and Nietzsche did see that mass-production of machines and the mechanization of the human masses was not the road to any paradise, capitalist or proletarian. They did foretell more about the twentieth century than any of their contemporaries. Marx and Engels unaccountably omitted to predict Lenin and Stalin; Carlyle and Nietzsche made a very good shot at them (not to mention Hitler, Mussolini and others). But, as Mr. Bentley shows, the doctrine of the hero has always been confused and inconsistent, and always been propounded by those whose attitude to life is ambivalent. Mr. Bentley himself is ambivalent towards his subject. He thinks that this sound and fury signified something but finds it difficult to explain what. He concludes with the mild observation that democracy needs leaders, an aristocracy of talent; a conclusion that would infuriate Carlyle or Nietzsche, who did not admire the characteristic democratic leader of the American or British pattern.

A. D. R.

Précis de dermatologie

Par J. Darier, A. Civatte et A. Tzanck. Cinquième édition par A. Civatte. Pp. v + 1,152. (Paris: Masson et Cie., 1947.) 1,700 francs.

THE appearance of a fifth edition of Darier's "Précis de Dermatologie" is an event of importance. The last edition appeared in 1928 and has long been exhausted. This book has become in France, where dermatology is an art less confined to the specialist than it is in Britain, part of the library of nearly every student.

The title is misleading, as the scope is more nearly that of a text-book than a précis. It is intended as a guide to diagnosis for the practitioner and as an introduction to dermatology for the student. General principles of treatment are indicated, but detail is omitted.

The book is divided into two main parts. The first classifies the skin diseases according to morphological appearances; the second part deals specifically with diseases grouped according to causal agents.

This is a complete guide to dermatology without omission of the rarities, and it is a book which no specialist need disdain.

The new edition has been edited and brought up to date by Dr. Civatte since the death of Darier. He is to be congratulated on his work, which includes all the recent advances in the subject in diagnostic measures, treatment methods, etc. This has been achieved without altering the fundamental design set by Darier. Many good new illustrations have been added.

I do not hesitate to say that this work has no equal in the English language, and that the new edition will consolidate its high reputation in the exacting school of French dermatology. James Marshall

The Theory of Functions of Real Variables

By Prof. Lawrence M. Graves. Pp. x + 300. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 20*s.*

THE exposition of a mathematical subject in its early stages of development is apt to require a bulky volume; the appearance of this concise treatise, covering so much ground, would consequently suggest that the theory of functions of real variables is now coming to maturity. Conciseness is partly achieved by the extensive use, especially in the earlier part of the book, of the symbolism of mathematical logic. In order to accustom the reader to the use of this symbolic method, many statements in the earlier chapters are given in duplicate, first in symbols and then in ordinary language.

The subjects covered in three hundred pages include the following: the real number system, sets of points, limits, the Riemann integral, uniform convergence, implicit functions, the Lebesgue integral and the Stieltjes integral. The exposition is careful and thorough, but so condensed that the beginner would find its perusal far from easy without the assistance of lectures or of a tutor: indeed, the author suggests as much in his preface.

It seems strange that, in his limit notation, the author makes use of the obsolete sign of equality, and not of the arrow-head as introduced by Leathem and Bromwich. T. M. M.

Physical Chemistry for Colleges

A Course of Instruction based upon the Fundamental Laws of Chemistry. By Prof. E. B. Millard. (International Chemical Series.) Sixth edition. Pp. ix + 682. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 22*s.* 6*d.*

Fundamental Principles of Physical Chemistry

By Prof. Carl F. Prutton and Assoc. Prof. Samuel H. Maron. Pp. x + 780. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1944.) 25*s.* net.

THESE two books are excellent examples of modern American texts on physical chemistry. The continued usefulness of the former is attested by the five previous editions, while the latter is a new work. Both make a thermodynamic approach to the subject and cover a considerable amount of ground. Although stated to be for beginners and designed for a single year's work, they do not confine themselves to the elements of the subject (which are covered very agreeably); they take in their stride such complex affairs as the Debye–Hückel theory, activity coefficients, the third law of thermodynamics, rotational spectra, modern formulations of reaction kinetics, etc. Remembering his own experience as a teacher, it is something of a mystery to the writer how the American student of chemistry and chemical engineering manages to digest all this in so short a time. Both books are well provided with problems.

J. A. V. Butler

GEOLOGY AND THE FUTURE OF COAL SUPPLIES

IN the presidential address to Section C (Geology) of the British Association, delivered at Dundee on September 1, Dr. Murray Macgregor stressed the vital need for closer co-operation between the miner and the geologist for the better-planned exploitation of the coal resources of Great Britain ; his address was followed by a discussion on the future prospects of those supplies.

In opening the discussion, Prof. H. G. A. Hickling suggested the importance of attention to the various classes of coal and their most effective use, rather than the estimation of total reserves. Even with the wasteful usage of former years, the total supply is unlikely to approach exhaustion within any period for which it is reasonable to plan at this time ; but it is less certain that one can be equally optimistic regarding some of the most valuable varieties. The first-class coking-coals, the anthracites and some other classes have hitherto been obtainable only from very limited areas in Great Britain, where they have been heavily wrought and the reserves greatly reduced. It is consequently a matter of major importance whether the remaining reserves are likely to yield a greater or smaller proportion of such types. Any useful forecast must be based on a knowledge of the distribution of existing coal types and its causes.

Coals vary in their characteristics from two main causes : first, from variation in the original deposit in respect of the contributory plant material, its mode and extent of decay and the nature and quantity of associated mineral matter ; and secondly, as the result of the varying extent of subsequent alteration under geological influences. Regarding the first, the long-familiar division of coals into 'brights' and 'hards' corresponds broadly to those ('brights') which have been formed mainly from pieces of organically saturated wood and bark, in contrast with the 'hards', which consist of a far more highly disintegrated mass of the most resistant plant residues, forming a minute micro-conglomerate. Chemical examination indicates that the substance of the bright coal was originally of relatively constant composition. The duller component is extremely variable both in visible constitution and in chemical characteristics.

Most seams contain a mixture of the two principal types of material. Their varying proportions, and especially the constitution of the dull coal, give rise to the characteristics of the different seams. The extensive investigations carried out by the Fuel Survey in Great Britain during the past thirty years have shown that individual seams commonly maintain their special features over considerable areas, while all the seams in any field usually show similar changes in 'rank' as they are traced from one part of the field to another. These latter changes are most familiarly indicated by alteration of the percentage of 'volatile' yielded by the coal on heating ; this diminishing progressively from the low-rank bituminous coals through the gas-coals, coking-coals and steam-coals to the highest grade anthracites.

Whether the variation of rank in any field be great or small, it follows the same pattern in all seams. Similar changes of rank are found in the vertical sequence of seams at any given point, though this very significant fact is commonly obscured by the individual characteristics of the seams unless a long vertical series can be examined. The rank rises with increasing depth, and accumulating evidence indicates considerable regularity in the rate of change. Our growing knowledge of the causes of the differences among coals leads to the possibility of a more accurate forecast of the probable quality of our remaining resources, and to the conclusion that, while we shall be compelled to work at greater depths, there will be some compensation from the inclusion of a measurably greater proportion of the higher-rank coals.

Dr. C. A. Seyler described his recent investigations into the mode of change of the main constituent (vitrains) of normal coals, as indicated by their increase of reflecting power as the coal advances in rank. Contrary to expectation, this alteration appears to be discontinuous, the reflecting power changing abruptly through a series of nine steps in geometrical progression, and terminating with the highest member, fusinite. In any coal the bulk of the vitrain belongs to one of the lower members, with smaller quantities of the next two or three and usually a little fusinite. As the rank of the seam advances to a critical point, each component present changes its reflecting power (and presumably its composition) one step upward in the series ; except, of course, the fusinite.

Exactly similar stepwise changes of the vitrinites are observed in coals which have been subjected to progressive alteration by the thermal metamorphism of sills and dykes. This is shown with exceptional completeness in the case of a Sumatra lignite, which has been changed progressively to an anthracitic condition through a series of stages closely corresponding with normal coals. It seems to afford conclusive proof that heat (and possibly pressure) is capable of accounting for the varying stages of alteration of normal coals.

Dr. A. C. Monkhouse gave an account of the work and results of the Physical and Chemical Survey of Coal Resources during the past twenty-five years by the nine coalfield survey laboratories and the Fuel Research Station at Greenwich. This has given a knowledge of the coal resources of Great Britain more complete than that of any other country in the world. Most of the important seams in all the principal fields have been examined in detail in many places. Analysis band by band has frequently shown how the quality of the coal may be improved by excluding harmful bands, or how particular sections may be put to specially valuable uses. The regional variation of the seams has been traced in detail, and the ground securely laid for a forecast of the changes likely to be encountered as the seams are worked into new areas. Valuable evidence of the variation of coals in the vertical sequence has been obtained by the examination of the series of seams encountered in the exploratory borings for oil.

Following the nationalization of the coal reserves, a rapid survey was undertaken so that a final assessment might be based not only on the quantity but also on a carefully defined estimate of the qualities of the coals likely to be worked in the various royalties during the 'valuation period' (usually a hundred years). The coals were divided into six classes defined by volatile yield and coking properties, and the whole results finally subjected to mechanical analysis so as to reveal the total amounts of each group likely to be worked. This could be compared with the estimated reserves of each type, and led to the satisfactory conclusion that no type is likely to be exhausted during the next century.

The work of the organisation has naturally been forced to branch in many directions as ever-growing demands have been made upon it. Much work has been devoted to examination and advice related to the open-cast coal developments. Problems concerning the sizing, cleaning and breakage of coal have been investigated. Weathering and storage have been studied, and methods developed for the preservation of coal-dumps with tar cover. The selection and treatment of coals to serve producer-gas units for road-transport vehicles was undertaken during the War, as also the selection of coals to produce active carbon. The loss of the normal sources of sulphur led to an active search for pyritic waste from coal, and the production of 33,000 tons of sulphuric acid from this source. The accumulated knowledge and experience were also utilized for the solution of problems for the Service departments. For the future, the work of this organisation must be of the highest value for the proper planning of coal production and for its most economic and profitable use by the consumer.

As an indication of the need for intensive geological study and practical exploration, Dr. G. H. Mitchell submitted a contribution concerning the problem as it affects the Midland coalfields of Coalbrookdale, the Wyre Forest, South Staffordshire, Warwickshire, South Derbyshire and Leicestershire. These are parts of a natural area of related coalfields containing seams of a limited range of low- and medium-rank coals. The industry and the resultant centres of dense population within the area are founded on these coals, and especially on those of better quality. Within the life-time of the next generation there must be a steady decline in output unless new fields are discovered. Even sooner, the deterioration in average quality as a result of the exhaustion of the better seams will become a serious problem. The matter is therefore urgent.

The geological sequence within each of the fields is fairly completely known. Evidence for the estimation of their mutual relations is available in the marine beds and mussel bands which have been traced from field to field. The actual position, extent and depth of such extensions of these fields as may still lie concealed below the younger rocks of the intervening areas may be doubtfully inferred as the result of intensive geological study. Exhaustive investigation of the evidence of Carboniferous and post-Carboniferous earth-movements, and of the consequent sedimentation and periods of erosion, must form the basis of a forecast. But results can be no more than probabilities and are inadequate for practical development. They can, however, suggest where borings may be located so as to yield the most valuable information. A programme of intensive work, in which boring and geological study proceed hand in hand, is likely to produce practical results at a cost quite infinitesimal in relation to the national importance of the matters involved. Since, however, the complexity of the problems we have now to face in the search for new areas of coal is greater than those hitherto encountered, the boring and exploration programme must needs be far more extensive than any previously undertaken.

Dr. G. M. Lees delivered a communication prepared in conjunction with L. N. Falcon on the relation of the search for oil to the discovery of new coalfields. One considerable buried field has already been proved in central Lincolnshire. Although too deep for present-day exploitation, there is good prospect that it may be at a lesser depth near the Wash. Farther south-eastward, extension of the Nottinghamshire coalfield has also been proved, with the possibility that it may link up with the Wash area. It is a remarkable fact that the Kent coalfield should be the sole example of a buried field hitherto located in Great Britain.

The search for oil has to commence from speculative geological deduction based on the limited surface evidence. Since the rocks and structures concerned are for the most part buried under unconformable cover, the most widespread indications, gathered from the Continent of Europe as well as from Britain, must be brought under review. Selected areas of sufficient promise are then subjected to gravity and magnetic survey to gain a broad generalized picture of the underground structure. From this background the most likely areas are more closely examined by seismic survey, and finally, where indications seem favourable, proved by boring.

The Midlands and south-central England have been generally studied. Of the areas selected within that region, one around Market Drayton and between there and Burton-on-Trent has been subjected to seismic survey. Boring will shortly be commenced. In three other areas, gravity and magnetic survey have been in progress for some twenty months, and results are now being analysed. These are: (1) an area in Wiltshire, where an eastward extension of the Somerset coalfield, or possibly an independent field, may be proved; (2) the Cotswold country in Gloucestershire, and perhaps southern Worcestershire; and (3) certain areas in Oxfordshire, possibly between Oxford and Reading. In addition to these, eastern Essex has been indicated for further study, while numerous other areas exist outside the present programme of investigation where extensions of existing fields or new fields may be found.

Dr. Lees concluded with special emphasis on the need for national effort in this matter. The present programme of private boring can only be subsidiary to the search for oil and at any time may have to be abandoned. Such a possibility is scarcely to be dispassionately contemplated.

The last contribution, from Dr. R. Holroyd, was on coal as a chemical raw material. Chemical industry is largely dependent on the availability of coking-coals; first, for the phenol, cresol, naphthalene and anthracene extracted from the two million tons of coal tar produced annually by coal carbonization, as well as benzene, toluene, xylene, etc.; and secondly, for the production of water-gas or hydrogen for chemical synthesis from about one million tons of coke with high melting-point ash.

The yield of aromatic raw materials is only about 1·5 per cent of the weight of the coal. In the past, this output of by-product by the carbonization industry has sufficed for chemical needs. Now, the anticipated demand greatly exceeds the supply, and investigation has therefore been directed to other sources. Considerable progress has been made in the development of petroleum-cracking plants, and it is probable that the chemical industry in future will be far less dependent on carbonization by-products, though it will continue to provide an outlet for them in so far as they can be produced economically.

The demand for 'synthetic gas' (carbon monoxide and hydrogen or hydrogen alone) is likely to increase considerably. The present high cost has compelled close examination of the efficiency of existing methods for its production and the investigation of new methods. A provisional scheme for a continuous process based on the 'fluid-solid' technique was described as offering considerable promise. German methods using oxygen may also be developed. While increased efficiency and lower costs must be the primary objective, it is likely that an even more important outcome may be the possibility of using a wider range of coals.

Thus it would appear that the chemical industry in future may be less exacting in its demands regarding types of coal and may obtain a large proportion of its raw materials from other sources. At the same time, it must remain a major consumer of coal as fuel, and its prosperity will depend on ample supplies.

George Hickling

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

After the annual general meeting of the British Non-Ferrous Metals Research Association on July 10, members and a small number of visitors were shown the laboratory buildings and facilities which the Association now possesses.

In 1930 the first of the Association's laboratories was established by conversion of a small factory near Euston Station, London, and just prior to the War additional laboratories were built on an adjacent site. During the War the original laboratory block was destroyed by enemy action, although the new building was fortunately undamaged. In preparation for post-war expansion, adjacent premises were afterwards purchased; their conversion is now almost completed, and application has been made for a licence to rebuild the war-damaged property. Completion of the present plans will provide a series of laboratories with a total of about 32,000 sq. ft. of floor space in an accessible position in central London. The extension of the laboratories and the corresponding increase in scientific staff, which together will enable a wider range of metallurgical work to be undertaken, have been made possible by the steady and continuing increase in the financial support which the Association receives from industry.

Expansion of the laboratory facilities was particularly required in the Physics, Mechanical Testing and Corrosion Sections, and new accommodation was needed for the recently formed Metal Finishing Section and to house metal-working equipment. Such metal-working equipment will be installed as is needed to prepare experimental alloys in wrought form for test purposes, but it is not intended for fundamental research on the working behaviour of metals and alloys, as it is hoped that such work will be done co-operatively with the British Iron and Steel Research Association in the latter's projected Flow of Metals Research Laboratory.

In accordance with the Association's policy of developing and using modern physical methods for the examination of metals, a Metropolitan-Vickers electron microscope has recently been installed in the physics laboratory and a study is being made of existing replica techniques. Attention will also be paid to the possibility of developing new replica techniques and alternative methods of examining metals in this instrument. Its full potentialities in metallurgical research have not yet been assessed, as its successful use depends so much on the development of satisfactory techniques, but a critical experimental survey is being made of its possible field of use so that members can be suitably advised. The high-tension source of the electron microscope will also be used for electron diffraction work, apparatus for which is being built in the Association's workshops. The Association's pioneering work of many years ago in the application of the spectrograph to the quantitative analysis of non-ferrous metals and alloys is being continued by a systematic study of the use of multiplier photocells in recording spectra and for investigation of excitation conditions.

The expansion of the Mechanical Testing Laboratory is largely to enable more work on creep and fatigue testing to be carried out, including fatigue testing at elevated temperatures, while the extension of the Corrosion Laboratories is called for by the great demands which are made on the Association to-day for further work in the field of corrosion, including stress corrosion.

Simultaneously with the re-planning and extension of its laboratories, the Association has recently reconsidered thoroughly its field of work and the organisation of its activities in relation to the needs of the industry it represents.

The non-ferrous metals industry is a varied group of industries comprising producers, manufacturers and users of the main industrial metals other than iron and steel. It includes a large number of firms with well-equipped and staffed research laboratories, and a number of small firms with little or no research facilities or technical staff of their own. The needs of the members, therefore, vary widely, and the Association's policy is first to carry out long-term researches designed to provide a basic understanding of the factors involved in the fabrication or service life of the materials in question, and secondly to help members, particularly the smaller ones, in the utilization of existing metallurgical knowledge in dealing with their immediate difficulties and in raising the technical efficiency of the industry.

The long-term research programme requires primarily a first-class scientific staff with all the equipment and facilities necessary for their work, but equally important is an adequate knowledge of the technology of the industry. The Association's staff is not by itself in a position to conceive and formulate the long-term projects which should be investigated, and for this purpose several industry research committees have been established consisting of the most highly qualified men of science available in the different sections of the industry. These committees are responsible, in co-operation with the staff, for the formulation of the research programme and for the appointment of sub-committees of industrial technicians, intimately acquainted with each particular problem, for the guidance and advice of the Association's staff in carrying out the work. These committees, of course, do not direct the research work in detail, which responsibility lies with the Director and senior staff, but serve to keep the staff fully informed on the industrial experience which is helpful during the course of the investigation.

At the other extreme, the problems of the small firm, which frequently needs information more than research, are dealt with by the Liaison Department with the backing of a comprehensive Library and Information Service. The Association's liaison staff maintains contact with the industry and with the research work in progress in the Association and elsewhere, and offers confidential service which is greatly appreciated by the small member in dealing with certain *ad hoc* problems which can be solved in the light of existing knowledge or which require only a small amount of work for their solution. If a problem entails a considerable amount of investigation, this can only be done either by including it in the general research programme or by putting in hand a special research at the cost of the member, the results of which must be made available to all members.

In general, therefore, in the research field the Association's programme of objective fundamental work is intermediate between the purely fundamental work unrelated to specific industrial problems which is proper to the universities, and the more *ad hoc* researches on manufacturing problems which are carried out in the research departments of the larger industrial concerns.

FOURTH INTERNATIONAL CONGRESS FOR MICROBIOLOGY

UNDER the presidency of Dr. Thorvald Madsen the Fourth International Congress for Microbiology was held in Copenhagen during July 20–26. It was attended by more than 1,100 delegates from some thirty-five countries, including a strong representation of more than two hundred persons from the British Isles.

The scientific work of the Congress was divided into nine sections which were concerned with: general microbiology, presidents, Sir Alexander Fleming (Great Britain) and Dr. J. Trefouël (France); medical and veterinary bacteriology, president, Dr. G. Ramon (France); viruses and virus diseases, president, Dr. Carl Kling (Sweden); serology and immunity, president, Prof. Th. Thjøtta (Norway); variation and mutation in micro-organisms, president, Dr. A. F. Blakeslee (United States); plant pathology and mycology, president, Prof. Johanna Westerdijk (Holland); soil and water microbiology, president, Dr. S. A. Waksman (United States); dairy and food microbiology, president, Dr. R. Burri (Switzerland); and industrial microbiology, president, Prof. A. J. Kluyver (Holland). There were, in addition, the four following: general sessions dealing with assimilation of carbon dioxide, Dr. C. H. Werkman (United States); viruses in general, Mr. F. C. Bawden (Great Britain); yeast in modern genetics, Prof. Ø. Winge (Denmark); and antibiotics and life, Dr. S. A. Waksman (United States).

More than three hundred papers were presented at the various sections, interest concentrating principally on the discussions concerning antibiotics—with particular reference to penicillin and streptomycin—diphtheria, pertussis, pathogenic streptococci, tuberculosis, brucellosis, poliomyelitis and influenza, the mechanism of infection and immunity, the physical and chemical investigation of antigens and antibodies, bacteriophage, induced mutation, virus diseases of plants and phytopathogenic fungi, soil ecology, micropopulation and nitrogen fixation, food poisoning, bacteriology of dairy products, brewing and fodder yeast production.

In connexion with antibiotics, Dr. P. M. D'Arcy Hart described the bacteriostatic action of licheniformin, derived from a strain of *Bacillus licheniformis*, against a number of Gram-positive bacteria including *M. tuberculosis*, and directed attention to the fertile field for exploration among the aerobic spore-formers. The classification of this group has now been reduced from its former chaotic state by the taxonomic studies of Nathan R. Smith, Ruth E. Gordon and F. E. Clark in the United States and of T. Gibson in Great Britain, which have placed nomenclature on a sure foundation. Dr. C. H. Andrewes and Dr. Forrest Fulton reported the setting up of a unit for the study of common colds in the buildings of the Haward Hospital, Salisbury, which has been planned for a long-term research project. Attempts are being made to cultivate the exciting factor, which is tentatively presumed to be a virus, or to reproduce the disease in some convenient animal. The development of these researches will be awaited with much interest.

Dr. A. Felix contributed a paper on the nature of bacteriophage. Although the view is held by most bacteriologists that bacteriophages are bacterial viruses, he thought that the facts could be explained with less strain on the imagination if we assume that bacteriophages are not separate biological entities and that their nature is determined by the specific antigenic substances from which they are derived. In the same section (III) Dr. W. I. B. Beveridge directed attention to the similarity of the viruses of mumps and influenza with regard to their hæmagglutination activity, growth in chick embryo and size of virus particles; while in Section IV Dr. F. Kauffmann described a diagnostic schema for the *coli* group based on antigenic features. He expressed the view that the taxonomy of the Enterobacteriaceæ should start with type-diagnosis based on serological features and that the old classification within the *coli* group, based on fermentation reactions, differentiating *B. coli commune*, *B. coli communior*, *B. acidi lactici*, etc., was obsolete.

With so much material for notice and for comment it is difficult to make selection of a few salient papers, but those on phage typing of *Shigella sonnei* (E. Hammarström), "Les Hyphomycètes prédateurs des larves de Nématodes parasites des plants et des mammifères" (R. Deschiens and L. Lamy), Dr. C. E. ZoBell's paper with reference to the depth at which bacteria are active in marine bottom deposits and the series of papers dealing with the production of fodder yeast are perhaps deserving of especial mention, which applies also to the technical excellence of Dr. R. W. G. Wyckoff's photographs illustrating his paper on electron microscopic study of the antigen-antibody reaction and to Dr. J. Comandon and Dr. P. de Fonbrune's film illustrating "Champignons prédateurs de Nématodes du sol".

While plant pathology and mycology were well catered for, one would have wished to see a sub-section of the Congress devoted to medical and veterinary mycology, a subject of growing importance and to which notable contributions have recently been made by the employment of new techniques and methods of research; in this connexion the names of N. F. Conant and C. W. Emmons in the United States and of J. T. Duncan in Great Britain come readily to mind. One may hope that at the next International Congress for Microbiology this important branch of mycology, and also the field of protozoology, will receive due recognition.

Apart from the general programme of the scientific work of the Congress a number of committees carried out duties of considerable importance. The Permanent International Commission for the Organisation of Congresses drafted new statutes for the International Association of Microbiologists (I.A.M.B.) which had become necessary on account of the relationship that the Association bears to the International Union of Biological Sciences (I.U.B.S.), of which it is now a microbiological section and is thus in organic association with the International Council of Scientific Unions (I.C.S.U.) and with the Division of Natural Sciences of the United Nations Educational, Scientific and Cultural Organisation (U.N.E.S.C.O.). Meetings of the Permanent International Committee on Bacteriological Nomenclature and of the Judicial Commission on Bacteriological Nomenclature were also held at which the "Proposed Bacteriological Code of Nomenclature" edited by R. E. Buchanan and R. St. John-Brooks was presented for approval and for subsequent publication in the *Proceedings* of the Congress.

Action was also taken by the Nomenclature Committee and the Permanent Commission in welcoming the proposal that the Centre de Collection de Type Microbiens, Lausanne, Switzerland, under the direction of Prof. Paul Hauduroy, should be associated with the International Association of Microbiologists, both with regard to the preparation of a "World Catalogue of Strains of Micro-organisms" and also in the formation of an International Federation of Culture Collections of Micro-organisms. These matters had already received the support and approval of U.N.E.S.C.O., and a small *ad hoc* Commission of the Nomenclature Committee of the Association was formed under the chairmanship of Prof. A. J. Kluyver for overall advice and the administration of any grants-in-aid that might in future be allocated.

A meeting of the *Salmonella* Sub-committee also took place under the chairmanship of Dr. F. Kauffmann. A new and revised report of the work of the *Salmonella* Sub-committee was presented for publication in the Congress *Proceedings*, and the sub-committee was reconstituted under the name of the "Enterobacteriaceæ Sub-committee" so as to include the consideration of problems dealing with *Shigella* and the *coli* group. New sub-committees of the Nomenclature Committee were also constituted dealing with the immediate study of the taxonomy and nomenclature of *Streptococcus*, *Clostridium* and *Mycobacterium*, and for the general outline classification of Schizomycetes to be considered at the next Congress. A meeting of a committee for Phage Typing, to which representatives from fourteen countries had been invited, was held under the chairmanship of Dr. A. Felix.

It was, perhaps, inevitable that the subject of biological warfare should obtrude itself at a congress of this nature, and the matter being raised at the meeting of the International Commission the following resolution was drafted for presentation at the plenary session of the Congress, where it was afterwards passed by acclamation:

"The Fourth International Congress for Microbiology joins the International Society of Cellbiology in condemning in the strongest possible terms all forms of biological warfare. The Congress considers such barbaric methods as absolutely unworthy of any civilized community and trusts that all Microbiologists throughout the world will do everything in their power to prevent their exploitation."

An invitation from the Brazilian Government to hold the Fifth International Congress for Microbiology in Rio de Janeiro in the latter part of 1950 was presented at the meeting of the Permanent Commission by the chief of the Brazilian delegation to the Congress—Dr. H. C. de Souza Araujo. This invitation was accepted by the members present with applause and was afterwards ratified at the plenary meeting of the Congress.

Apart from the exchange of scientific knowledge and the exploration of the ever-widening horizons of research, one of the most important functions of international congresses of this kind is the formation of fresh personal contacts and the renewal of old associations and friendships. This was peculiarly applicable to the present occasion when, owing to the brutal intervention of global war, nearly eight years had passed since a similar concourse had gathered in New York City under the shadow of a world catastrophe. The social side of the Congress's activities, which included much public and private entertainment, was an unqualified success, and it speaks much for the Danish Organising Committee, its general secretary, Dr. M. Björneboe, and the many friends of the Congress that their efforts were so completely vindicated. At the end of the week the delegates returned to their scattered homes with happy recollections of good fellowship, of high endeavour and of successful achievement.

RALPH ST. JOHN-BROOKS

OBITUARIES

Dr. H. T. Calvert, M.B.E.

WITH the death from heart failure of Harry Thornton Calvert in his seventieth year on September 23, there has passed away a leading authority on the science and technology of water supplies, sanitation, and the prevention of pollution of rivers and underground water resources. He was born in Leeds, Yorkshire, on May 3, 1878. Following his early education he proceeded to the Yorkshire College (now the University of Leeds), to study in the honours school of chemistry. Calvert was soon recognized as a student of more than average ability. On graduation in 1898, he was at once awarded an 1851 Exhibition and went to Leipzig, where he remained until 1901 and took the Ph.D. degree.

On return from Germany, Calvert served for a short time as a demonstrator under the late Prof. Arthur Smithells at the University of Leeds, before taking up an appointment as chemist to Messrs. Reckitt and Sons, of Hull, with which firm he gained valuable experience in chemistry applied to industrial problems. In 1903, he moved to become chemist to the West Riding of Yorkshire Rivers Board, a joint committee of local authorities which had been set up to administer the Rivers Pollution Prevention Acts. This change in his scientific activities marked the beginning of his interest in the problems of water supply and sanitation generally, a subject which remained his chief interest throughout the rest of his career.

At that time Dr. Maclean Wilson was chief inspector of the Rivers Board. Calvert and he were ideal partners in guiding this important work. They were not inspectors in the narrow sense of the word; but studied in detail the problems of treatment and disposal of sewage and the manufacturing processes in the West Riding which gave rise to the discharge of polluted waste waters. As a result they fully recognized the difficulties to be overcome, and devoted their energies largely to guiding and assisting managers of sewage disposal works and manufacturers in solving their problems. In consequence, the work of the Rivers Board reached a high standard and set an example to the rest of the world. Wilson and Calvert collaborated in writing the book "Trade

Waste Waters: Their Nature and Disposal", which has long been the authoritative work on this subject. It was while he was with the Rivers Board that Calvert was awarded in 1915 the D.Sc. degree of Leeds.

In 1920 Calvert moved to London to take up a new appointment as chemical inspector of the Ministry of Health, a post which gave him wide scope and in which he was eminently successful. When in 1927 the Department of Scientific and Industrial Research set up a water pollution research organisation, Calvert was the obvious choice as director of research, and he undertook this responsibility in addition to continuing his work for the Ministry of Health. He did not believe in rapidly developed schemes of a grandiose character, but in steadily building up on a sure foundation. This policy he followed in guiding the work of the Water Pollution Research Board in excellent partnership with every member of the Board, which was under the chairmanship of Sir Robert Robertson. By 1939, the research organisation had several outstanding achievements to its credit, including a comprehensive survey of the River Tees, an investigation into the effects of discharges of sewage into the River Mersey in relation to problems of navigation, improvements in methods of treatment of sewage, and the development of practicable methods of dealing with the problems of reducing pollution by such trade waste waters as those from beet sugar factories, milk depots, cheese and butter factories, to mention only a few items.

Calvert was recognized as an authority in his field not only in Great Britain, but also throughout the world; and he had close friendship with many professional colleagues on the Continent and in the United States. In addition to his many papers and addresses in Great Britain, including a Chadwick Public Lecture in 1926, he accepted an invitation in 1939 to give the Sedgwick Lecture in the following year at the Massachusetts Institute of Technology, but unfortunately was prevented by the outbreak of war from delivering the lecture. In 1944 he received the Kenneth Allen Award of the American Federation of Sewage Works Associations.

He took a keen interest in the work of the Institute of Sewage Purification, of which he was president in 1927, 1928 and 1939, and was a member of the Council of the Institute for many years. Calvert was also a prominent fellow of the Royal Sanitary Institute, and the Institution of Sanitary Engineers, a professional associate of the Institution of Water Engineers, a member of the Society of Chemical Industry, and a fellow of the Royal Institute of Chemistry and of the Chemical Society.

During the First World War, from 1916 until 1919, he was with the Department of Explosives Supply of the Ministry of Munitions, and his work was recognized by the award of the M.B.E. On the outbreak of war in 1939 he was seconded to the Ministry of Supply as deputy controller of sulphuric acid, which post he retained until his retirement early in 1947.

Calvert was a man of kind heart and generous disposition, with a marked ability in quietly getting boards, committees and staff working together amicably and efficiently, and all who worked with him came to know him as a close friend. He was devoted to his family. The death of his wife in 1937 was a severe blow to him. All three of his sons have had distinguished university careers, one in physics, a second in chemistry and engineering, and a third in arts and law. A. PARKER

Surgeon Rear-Admiral C. M. Beadnell, C.B., K.H.P.

SURGEON REAR-ADMIRAL CHARLES MARSH BEADNELL, who died at Petersfield, Hampshire, on September 27, was president of the Rationalist Press Association, Ltd., and the author of several scientific books. Born at Rawalpindi in 1872, he was educated at Cheltenham College; and after studying medicine at Guy's Hospital he joined the Navy as a surgeon in 1896. He came to intellectual maturity while the great evolution controversy was still raging, and fell under the spell of Huxley. He became an ardent rationalist, and although service conditions somewhat restricted the propagation of his views, he frequently contrived to give lectures on evolution to the 'lower deck'. On one occasion the commander-in-chief attended, and instead of administering the expected rebuke, he merely remarked that he had enjoyed the lecture very much; but, he added: "On second thoughts, Adam and Eve are good enough for me".

Beadnell's enthusiasm for science led him to buy, out of his own earnings, an X-ray apparatus, the first to be used in the Royal Navy. In the American-Filipino War he collected specimens of bullet injuries to skulls, when he found that the Filipinos did not bury their dead. During the Boer War, when pronounced medically unfit for front-line service he broke away from a hospital train and tramped all night to take part in the fighting at Graspan. The *Titanic* disaster stimulated him to invent an air-distensible waistcoat.

In 1922 Beadnell represented the Navy and Army Medical Departments at the International Congress of Surgeons at Washington. On his return he became head of Chatham Hospital, retiring at his own request four years later. Retirement brought him the opportunity to devote much of his time, and his gift for simple exposition, to general science and the cause of rationalism. The fire kindled in the great days of Huxley never died; but perhaps the strongest influence was that of W. K. Clifford. His intellectual integrity was as unquestionable as his physical courage, but he was no fanatic. In a revealing letter, written the day before he died, he declared that Clifford had brought him from "the respectable sphere of Agnosticism to that of Atheism; not of the blatant type, but of a convinced, quiet kind in which I would not argue in public on religious questions, if other officers I knew to be religiously persuaded happened to be present". He became a director of the Rationalist Press Association and succeeded Lord Snell as president in 1940. Among his publications were: "Evolution of Speech", "Picture Book of Evolution (after Dennis Hird)", "Origin of the Kiss", "Dictionary of Scientific Terms" and "An Encyclopædic Dictionary of Science and War".

Prof. Paul Guthnick

PROF. PAUL GUTHNICK was born at Hitdorf am Rhein on January 12, 1879. After studying under Küstner at Bonn, he became an assistant at the Berlin Observatory in 1901. After three years at the Bothkamp Observatory, he returned to Berlin in 1906 and moved steadily up in the scale of Observatory and University posts until 1921, when he succeeded Hermann Struve as professor of astronomy in the University of Berlin and director of the University Observatory at Berlin-Babelsberg. In 1927 he was elected an associate of the Royal Astronomical Society.

Guthnick's chief work lay in stellar photometry, and he was particularly successful in developing photo-electric methods, carrying out many pioneer investigations. He worked largely with stars of very small and irregular variations, but he also studied Mars and the satellites of Jupiter and Saturn. He applied photo-electric methods to measure the colour indices of stars, notably Nova Aquilæ 1918. His original and somewhat unorthodox outlook was reflected in theories that he put forward for several classes of variable stars.

He died in hospital in Berlin on September 6.

WE regret to announce the following deaths:

Prof. A. T. Cameron, professor of biochemistry in the University of Manitoba, author of well-known text-books on biochemical studies, on September 25, aged sixty-five.

Prof. J. Masson Gulland, F.R.S., Sir Jesse Boot professor of chemistry in University College, Nottingham, on October 26, aged forty-nine.

Prof. F. E. Lloyd, emeritus professor of botany in McGill University, Montreal, aged seventy-nine.

NEWS and VIEWS

Nobel Prize for Physiology and Medicine, 1947: Prof. Bernardo A. Houssay, For.Mem.R.S.

ONE part of the Nobel Prize for Physiology and Medicine for 1947 has been awarded to Prof. Bernardo A. Houssay, recently professor of physiology in the University of Buenos Aires (see *Nature*, November 23, 1946, p. 739). Before Houssay took up his investigations on the influence of the pituitary gland on carbohydrate metabolism, it was confidently believed that the posterior part of the gland was thus concerned. More than twenty years ago, Houssay and his collaborators showed without question that the anterior portion of the gland is of importance in this connexion, and their demonstration that the dog from which both the pituitary gland and the pancreas were removed survived much longer than the animal from which the pancreas alone was removed was of outstanding importance in demonstrating that carbohydrate oxidation can occur in the complete absence of insulin. It thus became clear that insulin enhanced glucose utilization in the body, while anterior pituitary secretions inhibited it; and in keeping with this, Houssay and others were later able to show that extracts of the anterior lobe exert a diabetogenic action in the normal dog.

Prof. Carl F. Cori and Mrs. Cori

THE other part of the Nobel Prize has gone to Prof. Carl F. Cori and Dr. Gerty T. Cori, of the Washington University School of Medicine. Prof. and Mrs. Cori have pursued a line of investigation which has now to some extent merged with that of Houssay and his colleagues. The Coris have investigated for the past twenty years or so the changes undergone by the glucose molecule, and the enzymes responsible for the changes, in the processes of glycogen formation and breakdown in the animal body. In 1939 they were able to prepare for the first time an enzyme which catalysed the synthesis *in vitro* of a polysaccharide resembling starch and glycogen. More recently they have examined the action of the enzyme hexokinase, responsible for the phosphorylation in the body of glucose to glucose-6-phosphate at the expense of the conversion of adenosine triphosphate to adenosine diphosphate. The Coris have been able to show that anterior pituitary extract and insulin exert antagonistic actions on this enzyme system *in vitro*, anterior pituitary extracts depressing hexokinase activity, and insulin neutralizing this depression. This observation goes a long way to explain in terms of enzyme systems the action of some of the hormones the physiological investigation of which has been the pursuit of Houssay and his collaborators.

Physiology at St. Bartholomew's Hospital Medical College: Prof. K. J. Franklin

BY the appointment of Dr. K. J. Franklin, acting director of the Nuffield Institute for Medical Research, Oxford, to the professorship of physiology in the University of London tenable at St. Bartholomew's Hospital Medical College, Oxford loses a scholar who has served the University for many years, and 'Bart's' reclaims a former student. After serving in the R.F.A. in the First World War, Franklin went as a classical scholar to Hertford College, Oxford. He turned to biology and medicine, gaining the Welsh Memorial Prize for anatomical drawing in 1920, and first-class honours in animal physiology the following year. After a period as lecturer in Oxford and in London, he returned to Oxford in 1924 as fellow of Oriel and demonstrator in the Department of Pharmacology, but a year later was off again as a Radcliffe Travelling Fellow, which appointment he combined with an assistant professorship of physiology in the University of Michigan. He shared the Radcliffe Prize for research in 1933, and was dean of the Oxford Medical School from 1934 until 1938, and acting dean during the Second World War.

Apart from teaching, of which Franklin has done a great deal in Oxford (his pupils number more than a hundred), he divided most of his time between the experimental study of the circulation in general and veins in particular, and the history of medicine with particular reference to the circulation. In the latter studies Franklin's early classical training served him in good stead. When the Nuffield Institute of Medical Research was established in 1935, Franklin accompanied Prof. J. A. Gunn from the Department of Pharmacology as the Institute's assistant director. Here he turned his attention to the study of the circulation by cine-radiography, a technique which he studied under Janker in Bonn. In this work he collaborated with Dr. A. E. Barclay and the late Sir Joseph Barcroft; their studies of the fœtal circulation have already been published. More recently Dr. Trueta joined the team, and their study of the renal circulation has just been published by Basil Blackwell of Oxford. This work has provided a very useful technique that will no doubt be applied to other organs, and has also given important physiological information regarding the mechanism of the circulation. Since Prof. Gunn's retirement, Franklin has been acting director of the Institute. No doubt Franklin will continue similar studies in London when he is able to gather together the elaborate equipment needed. In the interval of doing this, we look forward to a continuation of his publications on the history of physiology.

Botany at McGill University: Prof. Nicholas Polunin

THE recent appointment of Dr. Nicholas Polunin to the Macdonald professorship of botany in McGill University, Montreal, was an especially suitable one in that arctic botany has long been one of Dr. Polunin's chief interests and he has devoted special attention to the flora and ecology of north-eastern Canada. Since 1930 he has made several expeditions inside the Arctic Circle, ranging from Lapland and Spitsbergen in the east through Greenland to the territories covered by the Canadian Eastern Arctic Patrol. The Canadian Department of Mines and Resources has sponsored his work on "The Botany of the Canadian Eastern Arctic" to be published in four parts, three of which have already appeared.

Dr. Polunin went to Christ Church, Oxford, with an open scholarship in natural science in 1927. He graduated in the Final Honours School of Natural Science in 1932 and was awarded a Goldsmith's Senior Studentship. Later he received the degrees of D.Phil. and D.Sc. In 1933 he was awarded a Henry Research Fellowship at Yale University, of which he holds the degree of M.S. (1934). Returning to Oxford he was elected to a senior research scholarship at New College, during the tenure of which he was also research associate at Harvard (1936–37). Since 1938 he has been curator of the Fielding Herbarium, Department of Botany, Oxford, and in 1939 was elected University demonstrator. In 1946 he was elected to a research fellowship at New College. With the cessation of hostilities, fieldwork again became possible, and in 1946 Polunin was granted leave of absence from Oxford in order to allow him to accept a visiting professorship at McGill and take part in further expeditions to the north-east of Canada, which he has done during the summers of 1946 and 1947.

Brigadier D. P. J. Kelly

BRIGADIER D. P. J. KELLY has recently retired from the post of controller of the Royal Army Educational Corps. Born in London in 1887 and educated at the University of Cambridge, he was commissioned into the Connaught Rangers in 1915 and was gazetted as a captain in the Army Educational Corps in 1920. Following eleven years of service in India, he returned home in 1940 and was appointed command education officer in Scottish Command. In this post he was responsible for the introduction of the war-time scheme of education, and the friendly relations which continue to exist between the Army and the Scottish universities, the Scottish Education Department and the voluntary bodies engaged in educational work in Scotland, owe much to his ability and personality. Selected as controller in 1944, at a time when the educational scheme for the release period was being planned, he worked in the closest co-operation with Sir Philip Morris. More recently, he has been actively engaged under Major-General Cyril Lloyd in planning the future organisation of the Royal Army Educational Corps.

Scientific Development in China

THE members of the Chinese Association for the Advancement of Science, the Natural Science Society of China, the Chinese Astronomical Society, the Chinese Meteorological Society, the Chinese Geographical Society, the Chinese Zoological Society and the Chinese Anatomical Society, gathered at their joint annual conference in Shanghai during August 30–September 1, passed resolutions, the substance of which is printed below, on the control of atomic energy and on the development of scientific research in China.

(1) Atomic research. Chinese scientific workers feel that the probing into the mysteries of atomic energy, like scientific research work in all other fields, should have as its objective the promotion of human welfare. The energy of the atomic nucleus was successfully released at a time when the democracies were locked in a life-and-death struggle with the totalitarian States; and quite naturally it was taken advantage of in the making of weapons of war. This is unfortunate for atomic energy and also for scientific research. Now that the War has been concluded and the democracies are endeavouring to bring about world co-operation, atomic research should be freed from its close-guarded secrecy, to be directed towards the advancement of the application of other achievements in atomic research.

(2) Scientific research in China. The Chinese as a race are still facing starvation and other acute shortages in this atomic age, backwardness in the development of science being one of the causes. The significance of such development is in its power to raise proportionately the standard of living. Sufficient emphasis has not hitherto been given to the fundamental sciences; and a mature status in scientific work will not be acquired suddenly by the importation of a few instruments for atomic studies. Foundations must be laid first by the strengthening of the physical equipment for science education and by extending adequate facilities and stable living conditions to teaching and research personnel in China. What is more important, China should adopt a definite and long-range plan for the development of scientific undertakings, with the necessary budgets to carry it out to the fullest extent. If science is to serve as an important contributing factor in the reconstruction of China, it must be made to stand on firmer ground; scientific development cannot be bought ready-made.

Chinese Association for the Advancement of Science

THE Chinese Association for the Advancement of Science (formerly the Science Society of China) held its twenty-fifth annual meeting during August 30–September 1 at the Academia Sinica and National Medical College of Shanghai, Shanghai, with the Natural Science, Astronomical, Meteorological, Geographical, Zoological and Anatomical Societies of China. Mr. H. C. Zen presided over the meeting; Dr. W. H. Wong discussed secrecy in scientific research and its effects, and Dr. K. C. Chu emphasized the utilization of scientific knowledge for peace. Besides the presentation of papers in different sections, there were discourses on "Atomic Energy and Peace", "Improvement of Scientific Education in China", and other public lectures.

Home and Factory Power Exhibition

A SMALL exhibition entitled "Home and Factory Power" was opened in the main hall of the Science Museum by Lord Citrine, chairman of the British Electricity Authority, on October 21. The exhibition will remain open until the end of January and is intended to show visitors that it is their personal responsibility to avoid the overloading of power stations and gas plants during the peak hours. In his opening remarks, Lord Citrine anticipated a five-year shortage of electrical plant in spite of the fact that the manufacturers are attempting to double their 1938 output. Consequently, with electric power demands already 60 per cent above the 1938 level, and the effects of the war-time lag in extensions and maintenance still to be caught up, there are bound to be power cuts in this and succeeding winters unless the domestic consumer is much more careful. In the exhibition this point is brought home by a series of working models. Thus, by pressing a button the visitor brings on an electric fire but at the same time stops the operation of a model workshop. The workers sit down to wait until the fire is switched off again. An illuminated label at the same time stresses the need to avoid the peak load hours of 8–10 a.m. and 4–6 p.m. The loads taken by various domestic gas and electric appliances are shown by a colourful series of panels, which also suggest how to make reasonable savings without undue austerity.

American Institute of Physics

MR. CLEVELAND NORCROSS, formerly executive secretary of the Office of Scientific Research and Development, the official organisation which co-ordinated American scientific work during the War, has been appointed to the newly created post of assistant director of the American Institute of Physics; Dr. H. A. Barton continues as director of the Institute. The administrative change has been necessitated by the enormous increase in the administrative burdens of the Institute, largely due to the continued increase in the number of physicists (the number has trebled in the past ten years, but which is by no means sufficient yet to meet the demands of industry, government research and teaching establishments), and to the growing recognition by the general public of the part that physics does and should play in industrial and national progress. The director will continue to be responsible to the governing board for the general supervision of the Institute, but will be primarily responsible for matters of policy and relations between physical organisations and allied bodies. Advertisement, appointments, public relations, and attention to matters affecting the member societies of the Institute will be the main concern of the assistant director.

International Scientific Film Association

AT a congress in Paris during October 2–9, arranged jointly by the Institut de Cinématographie Scientifique and the Scientific Film Association, it was decided to form an International Scientific Film Association. A provisional constitution was agreed by the delegates from twenty-two countries, under which the Association will have a main meeting each year, but between these main meetings the affairs of the Association will be managed by a council comprising five officers and seven other members. The Council for the present year is: *President*, M. Korngold (Poland); *Vice-Presidents*. J. Maddison (Great Britain) and Prof. Pinto (Brazil); *Hon. Secretary*, M. Jean Painlévé (France); *Hon. Treasurer*, M. Sallaz (Switzerland); and one delegate each from Australia, Austria, Belgium, Canada, Czechoslovakia, Malaya and Mexico. The Association will be concerned with all aspects of scientific film matters. The exchange of information through the office of the Association (which will be established in Paris at an early date) will begin at once on scientific and technical films that are already available for exchange, on methods of appraisal, and on customs regulations on the exchange of films. Concurrently with each annual meeting of the Association, which will be held in different countries by invitation, there will be an examination of new scientific and technical films. The 1948 Congress is to be held in Great Britain in October; arrangements are being put in hand by the Scientific Film Association of Great Britain, 34 Soho Square, London, W.1.

Archæological Work in Greece

DURING the war years little archæological excavation was possible in Greece; but here and there minor discoveries were made, and these are summarized in the annual report of the Committee of the British School of Archæology at Athens. It appears in the *Journal of Hellenic Studies*, 64 (1944), and carries the story down to 1945. There are some illustrations, including a portion of a tholos tomb discovered near Knossos.

University of London: Appointments

THE following appointments in the University of London have been announced: Prof. Henry Barcroft, since 1935 Dunville professor of physiology in the Queen's University of Belfast, to the University chair of physiology tenable at St. Thomas's Hospital Medical School as from January 1, 1948; Dr. T. D. Day, to the University readership in pathology tenable at St. Thomas's Hospital Medical School; Dr. Russell Fraser, to the University readership in medicine tenable at the British Postgraduate Medical School; Dr. C. J. O. R. Morris, to the University readership in chemical pathology tenable at the London Hospital Medical College.

The title of professor emeritus of mining geology in the University has been conferred on Prof. W. R. Jones on his retirement from the chair of mining geology at the Imperial College of Science and Technology.

The degree of D.Sc. has been conferred on the following: Mr. Sachindranath Dasgupta (Imperial College of Science and Technology); Mr. Norman Davy; Mr. R. L. Knight (Wye College); Mr. W. S. Martin (Imperial College of Science and Technology); Prof. Claude Rimington (University professor of chemical pathology, University College Hospital Medical School); Mr. Yung Chow Wong (King's College).

Announcements

A JOINT conference of the Midland Branch and the X-ray Analysis Group of the Institute of Physics to discuss "The Structure and Physical Properties of Metals" will be held at Birmingham during November 20–21. Further particulars of the meeting, which is open free of charge to all who are interested, can be obtained from J. N. Kellar, honorary secretary of the X-ray Analysis Group, Crystallographic Laboratory, Cavendish Laboratory, Cambridge.

THE annual conference of the Agricultural Section of the Association of Scientific Workers will be held during November 8 and 9 at Gas Industry House, Hyde Park Corner, London. Sir John Fryer, secretary of the Agricultural Research Council, will address the first session at 3 p.m., which is open to all agricultural scientific workers.

DR. WILLIAM A. HAMOR, of the Mellon Institute, Pittsburgh, has been appointed editor of the Chemical Monographs of the American Chemical Society. This series of reference volumes now numbers 105.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Adsorption Apparatus and the Separation of Aspartic and Glutamic Acid

THE need has been felt in this laboratory for a simple apparatus capable of recording eluate concentrations by chemical means. The main features of an apparatus made for this purpose are: a syringe to force the solution through the adsorption column, from which a flexible canula and a capillary-drop tip convey the eluate to a rotating metal drum, on which a filter paper is fastened. The drop tip is pushed along the lowest generatrice of the cylinder and at regular intervals lifted up to the paper, where a drop of the eluate is deposited. The device for this lifting (not shown in Fig. 1) is operated from a cog-wheel on the left end of the drum. Syringe, drum and drop tip are driven synchronously by an electric motor through a system of cog-wheels and threadworms.

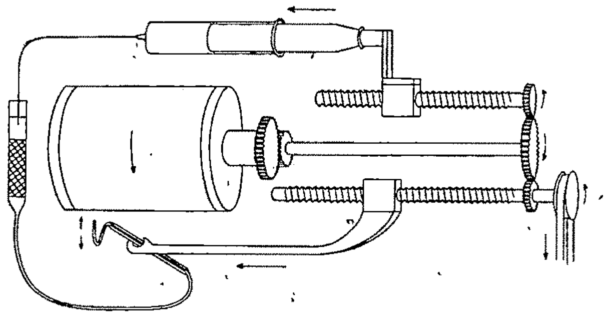

Fig. 1. SCHEMATIC DRAWING

The paper can be either used directly, when dyes are analysed; or prepared in advance with some reagent which, during the run or after some special treatment, gives a colour with the eluted substances; or afterwards sprayed with a suitable reagent solution. After development, if this is needed, the colour intensities of the spots are compared subjectively with each other and with spots obtained from solutions of known concentration.

The model apparatus is built in a compact manner on a metal plate, 140 mm. × 310 mm. The drum is 120 mm. long and 75 mm. in diameter. Twenty spots are obtained for each revolution of the drum, to which corresponds a 10 mm. displacement of the drop tip. About ten revolutions can be run, which means a total of about 200 spots, that is, with a 20 ml. syringe one obtains one analysis for each 0·1 ml. As the quantity deposited on the paper is about 3 μl., it is seen that the major part of the eluate will flow down from the drop tip, and if the liquid is collected here, a correction can be made for the substance lost in the spots. As the next step I intend to construct a synchronous eluate collector, which can change the eluate tubes for, say, each fourth spot. (A similar apparatus has been described by Moore and Stein[1].)

The apparatus is simple and relatively inexpensive, it is very convenient and omits much work with continuous interferometer readings or excessive eluate fractionating and analysing[2,3]; but one must know some good spot test reaction for the substances investigated. A great advantage over physicochemical methods is that this apparatus works independently of the solvent, which can be changed during the run without affecting the spot reactions. Likewise, other substances can be present without harm, provided they do not give a colour reaction. Sometimes the chemical method will make it possible to observe simultaneously the individual concentrations of two or more substances.

In order to test the apparatus, I studied the behaviour of the two dicarboxylic amino-acids on a column of the ion exchange resin 'Amberlite IR—4'. It was found that, after adsorption from an aqueous solution, both of them were eluted with N hydrochloric acid at a high rate, obviously by being displaced by the strong acid front. With smaller concentrations the aspartic acid was overtaken by the hydrochloric acid front, while the glutamic acid was still more or less displaced. The best results were obtained with about $N/100$ hydrochloric acid, but even here the separation was not complete. Better results were obtained with acetic acid, which in a concentration of 0·05 per cent gave a fairly good separation. Two control runs were made to test the separation:

(1) About 3 mgm. each of the two amino-acids were adsorbed in a glass filter on 630 mm.^{3} of 'Amberlite IR—4B', pretreated with N hydrochloric acid and water[4]. The elution was performed from a 10 ml. syringe, which gives 1·4 ml. for each revolution of the drum, that is, one spot for each 0·07 ml. First, 11 ml. of 0·05 per cent acetic acid were forced through to elute the glutamic acid, and afterwards, with a new paper on the drum, 4 ml. N hydrochloric acid to elute the aspartic acid, which comes out too slowly when the dilute acetic acid is used. After the two runs, which lasted for 70 min. and 30 min. respectively with a 10 min. interval between, the papers were sprayed with a ninhydrin solution and heated. During the runs, eluates corresponding to each revolution of the drum had been fractionately collected, and after the development they were poured together in four fractions (see Fig. 2). These were analysed by the micro-Kjeldahl procedure, which gave the following results. (The somewhat high value for aspartic acid nitrogen in this preliminary analysis can be due to a contribution from the resin, when this is eluted with N hydrochloric acid[4].)

RESULTS OF THE MICRO-KJELDAHL DETERMINATION

Fraction	I	II	III	IV
μ gm. nitrogen found	10	302	4	319
Corrected for substance in the spots	10	315	4	332
μ gm. nitrogen calculated	(0)	325	(0)	311

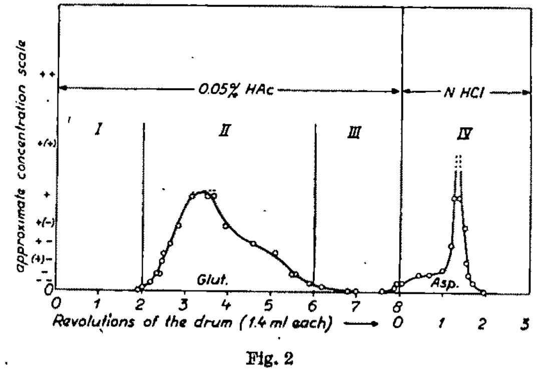

Fig. 2

(2) In another experiment the eluate was divided into two fractions, which were examined by one-dimensional paper chromatography with phenol–0·1 per cent ammonia–coal gas[5]. Also in this manner the effectiveness of the separation was entirely confirmed.

While several methods have been described, using the column procedure with inorganic adsorbents or the batch procedure with 'Amberlite IR-4' for the separation of the two dicarboxylic amino-acids, this method is the first to use an ion exchange resin in flowing chromatography for this purpose.

Note added in proof. While this letter was in the press, I was told that Consden *et al.* are about to publish a similar method.

BIRGER DRAKE

Institute of Biochemistry,
Uppsala.
June 26.

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[1] Stein and Moore, lecture at the American Chemical Society Congress, April 1942 (not yet published).

[2] Claesson (Diss.), *Arkiv f. Kemi, Min. och Geol.*, 23 A, No. 1 (1946).

[3] Strain, "Chromatographic Adsorption Analysis" (New York, 1942).

[4] Tiselius, Drake and Hagdahl, *Experientia*, 3, 651 (1947).

[5] Consden, Gordon and Martin, *Biochem. J.*, 38, 224 (1944).

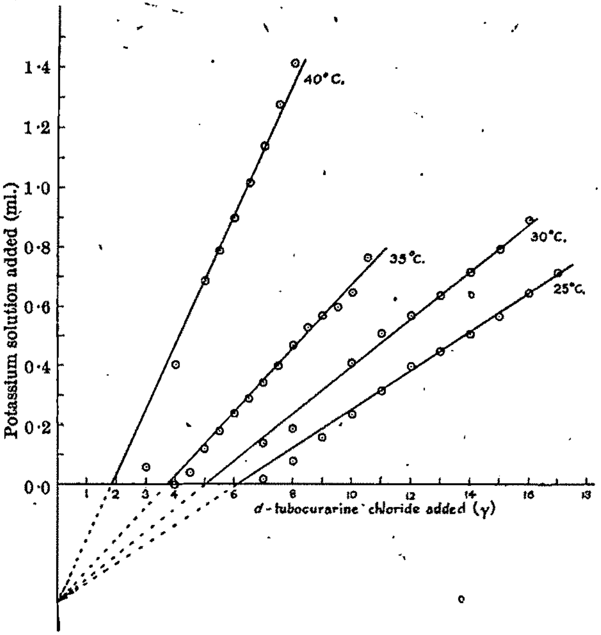
[6] For references, see, for example, Cannan, *Ann. New York Acad. Sci.*, 47, Art. 2, 150 (1946).

Antagonism Between Curare and the Potassium Ion

IT has been known for some time that a fall of temperature can reverse the motor end-plate blocking action of curare[1]. There seems to be two possible explanations of this strange phenomenon. The simplest hypothesis is to regard the reaction between curare and the receptor as a reversible dissociation which increases with decreasing temperature, a most unusual assumption. Alternatively, we might assume that the curare was being antagonized by some naturally occurring substance (cf. Ing and Wright[2] in this connexion), and that as the temperature was lowered the competition went against the curare. Since Wilson and Wright[3] have shown that potassium antagonizes curare, we investigated this competition quantitatively in order to determine the influence of temperature on the antagonism between added curare and the naturally occurring potassium ions.

Enough curare (*d*-tubocurarine chloride) was added to a slip of rat diaphragm to paralyse to a steady value of 50 per cent. More curare and Tyrode containing 100 times the normal amount of potassium chloride were then very carefully added in such a way as to keep the block steady at 50 per cent. In this way, it was found possible to back-titrate curare with the K^+ ion. The results (see graph) show that at constant temperature curare and potassium are in direct linear antagonism, and that within the limits of experimental error the graphs on extrapolation pass through the vertical axis at a point corresponding to zero potassium concentration in the fluid surrounding the muscle. The point at which each line crosses the horizontal axis is a measure of the dose of curare which causes a 50 per cent block in the presence of the amount of potassium normally present in the bath.

It is clear, therefore, that as the temperature falls, the dose of curare required to cause a 50 per cent block is increased to such an extent by the potassium normally present in the preparation that about three times more curare is required at 25° C. than at 40° C. to give the same effect. We therefore consider that the reversal of the action of curare with a fall of temperature is quantitatively explained by the second hypothesis mentioned above, namely, that curare is competing with naturally occurring potassium ions and that as the temperature is lowered the competition favours the potassium ion. Moreover, it provides an experimental basis for the understanding of the charge-density theory of the relationship between structure and action in drugs with curariform actions[4].



RELATIONSHIP BETWEEN *d*-TUBOCURARINE CHLORIDE ADDED TO A 40-ML. BATH AND THE AMOUNT OF TYRODE SOLUTION CONTAINING 100 TIMES THE NORMAL AMOUNT OF POTASSIUM CHLORIDE REQUIRED TO MAINTAIN THE NEURO-MUSCULAR CONDUCTION IN THE PREPARATION IN A STATE OF 50 PER CENT BLOCK

It is difficult to avoid the conclusion that, before it can block, curare must displace potassium, and that voluntary muscle possesses a powerful positive charge-seeking mechanism.

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Hippuric Acid Formation from Glycine and Dibenzoylphosphate

MONOBENZOYLPHOSPHATE and dibenzoylphosphate were synthesized by letting benzoylchloride react with a mixture of silver phosphate and orthophosphoric acid in a way similar to that described by Lipmann[1] in his fundamental work on monoacetylphosphate.

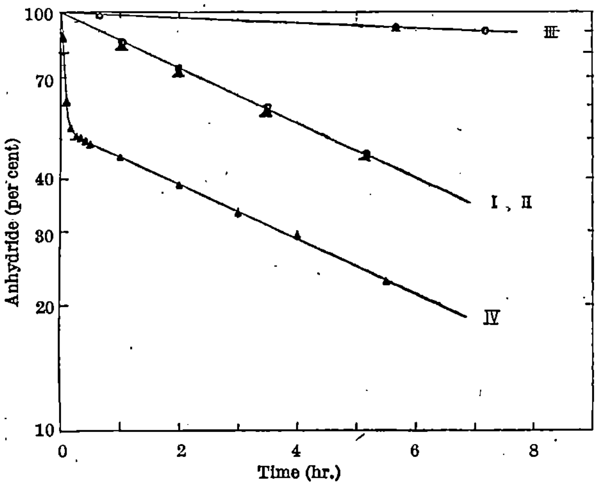
Monobenzoylphosphate has been isolated as the disilver salt, $(C_6H_5CO)\,PO_4Ag_2$; dibenzoylphosphate as the crystalline sodium salt $(C_6H_5CO)_2PO_4Na$. Both compounds undergo spontaneous hydrolysis in neutral aqueous solution. At 37° in $M/30$ phosphate buffer, pH 7·4, sodium monobenzoylphosphate has a half-life time of about 4½ hours. Sodium dibenzoylphosphate is much more stable: half-life about 45 hours under the same conditions. Both react with concentrated hydroxylamine (1 molar) at pH 7·4 to form one molecule of benzhydroxamic acid per anhydride group. The benzhydroxamic acid formed can be detected and determined in the form of its red complex ferric salt (max. absorption 525 mμ) (cf. Lipmann and Tuttle[2]).

At 37°, pH 7·4 monobenzoylphosphate does not react with glycine; however, one of the anhydride groups of dibenzoylphosphate reacts very rapidly with glycine, as can be seen from the following experiment.

The following mixtures were incubated at 37° C.:

(I) 5 ml. $M/15$ phosphate buffer, pH 7·4 + 5 ml. $M/50$ monobenzoylphosphate.
(II) 5 ml. $M/5$ glycine in $M/15$ phosphate buffer + 5 ml. $M/50$ monobenzoylphosphate.
(III) 5 ml. $M/15$ phosphate buffer, pH 7·4 + 5 ml. $M/100$ dibenzoylphosphate.
(IV) 5 ml. $M/5$ glycine in $M/15$ phosphate buffer + 5 ml. $M/100$ dibenzoylphosphate.

Samples were taken from time to time and the anhydride groups determined by the hydroxylamine method. In the accompanying graph, the results for I–IV have been plotted on a logarithmic scale against the time. It is evident that, under the experimental conditions, glycine has no influence on the breakdown of monobenzoylphosphate. The situation is, however, very different for dibenzoylphosphate. In the presence of glycine, half its anhydride groups disappear within a few minutes, and the residual groups break down at the same rate as monobenzoylphosphate.



Acetone-titration showed that NH_2-groups disappear during the reaction; hippuric acid formation has been qualitatively demonstrated by the partition chromatography method[3] using ethyl acetate and water as the two liquid phases.

The reaction can thus be written

$$(C_6H_5CO)_2\,PO_4^- + {}^+NH_3CH_2COO^- = C_6H_5CONHCH_2COO^- + C_6H_5COPO_4^{=} + 2H^+.$$

The corresponding reaction has been observed with ornithine and lysine too.

The present results serve to demonstrate that a peptide linkage can easily be formed by spontaneous non-enzymic reaction, from an amino-acid and a diacylphosphate, under physiological conditions (pH and temperature). It is suggested as a working hypothesis that diacylphosphates or substituted acylphosphates rather than mono-acylphosphates[4,5] could be the intermediary activated state of the carboxyl groups in the peptid-bond synthesis. It can easily be imagined that carboxyl groups of amino-acids, or their precursors, could be activated by phosphate groups bound to other cell constituents; special attention should be given to nucleic acids in view of the idea that they are involved in the protein synthesis[6,7].

It should also be pointed out that Lipmann[8] was unable to find any influence of monoacetylphosphate on the acetylation of sulphonamides, although the role of phosphorylation in the process strongly pointed to an intermediary formation of acetylphosphate. In the light of the results reported above, the failure of added monoacetylphosphate to act as acetylating agent could possibly be explained by assuming that the real phosphorylated agent is a substituted acetylphosphate.

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Methionine in Urine

In 1944 Albanese, Frankston and Irby[1] published their hydrogen peroxide – perchloric acid oxidation method for the estimation of methionine in protein hydrolysates and human urine. They stated: ". . . the applicability of the procedure to the urine was established by means of a study which demonstrated that the normal urinary constituents failed to react as methionine. This practice was further justified by the observations that the ingestion of *dl*-methionine by normal individuals resulted in a prompt elevation of the methionine level in the urine, as determined by our method. From a limited series of observations, it has been found that the normal adult (male) on a normal diet excretes 247 to 494 mgm. of methionine daily."

According to Cantarow and Trumper[2], the daily amount of amino-acid nitrogen in the urine ranges from 0·1 to 0·2 gm. Thus a daily output of 35 mgm. of amino-acid nitrogen (equivalent to 370 mgm. of methionine, average value) represents 23 per cent of the total amino-acid nitrogen (equivalent to 150 mgm., average value).

Under the direction of Dr. T. F. Dixon, many attempts were made in these laboratories to isolate the methionine from specimens of both human and pregnant mares' urine. The urines were titrated according to the method of Albanese, when methionine excretion values in the case of human urine came within the stated range. The horse urine averaged

440 mgm. of methionine per litre of urine. All attempts to isolate the methionine were fruitless, and the experiments were abandoned. Interest was revived, however, when Dent[3] showed that the filter-paper chromatography technique could be applied to human urine. He demonstrated the presence of at least two amino-acids of R_F values 0·37 and 0·57 (glycine and alanine ?). No mention was made of methionine, and presumably it was not revealed.

Experiments were then conducted in these laboratories in a further attempt to establish the presence of the amino-acid in normal urine. A pooled sample was divided into two equal parts, and to one was added solid *dl*-methionine, at a concentration of 0·25 mgm./ml. The two specimens were chromatographed side by side and finally treated with ninhydrin. If the claim made by Albanese *et al.*[1] had been correct then the colour intensity of the methionine spot in the sample of urine with added methionine should have been approximately twice that given by the original sample. The two papers were compared, when they were seen to differ by one intensely coloured spot, present in the sample containing added methionine. Nothing whatever could be observed in the corresponding position on the other paper.

It thus appears that methionine does not occur as such in normal urine. Presumably the titratable 'methionine' of Albanese *et al.*[1] is a conjugated form or derivative, the reducing properties of which correspond to those of methionine itself.

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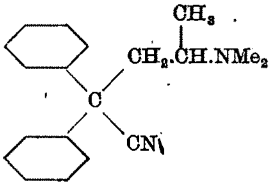
Optical Isomers of Amidone, with a Note on *iso*Amidone

l-AMIDONE has been briefly reported[1] to be an outstanding analgesic with about twice the activity of morphine, and this has recently been confirmed by us[2]. As no further chemical or pharmacological details appear to have been published, we give below a summary of our work in this field.

Attempts to resolve *dl*-amidone (II) using a number of optically active acids were unsuccessful. With *d*-tartaric acid it formed a diastereo compound, *dl*-amidone *d*-bitartrate, m.p. 128–133°, which crystallized unchanged from acetone and with alkali gave *dl*-amidone. The penultimate 1 : 1-diphenyl-3-dimethylaminovaleronitrile (I), on the other hand, was readily resolved by means of *d*-tartaric acid in wet acetone, from which the *l*-nitrile *d*-bitartrate (IV) crystallized in needles, m.p. 109–112°, $[\alpha]^{20}_D = +16°$ ($c = 1·44$ in water). The corresponding *d*-nitrile *d*-bitartrate (V), m.p. 66–70°, $[\alpha]^{20}_D = +5°$ ($c = 1·62$ in water), was obtained from the acetone mother-liquors by recrystallizing the crude product from wet acetone-ether. The *l*- and *d*-nitriles from (IV) and (V) were readily converted into *l*- and *d*-amidone respectively by means of ethyl magnesium bromide. Comparative data for these bases and their salts are given in Table 1. It will be seen that the salts of the optically active nitriles have anomalous rotations in water.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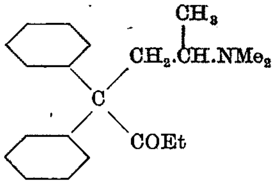
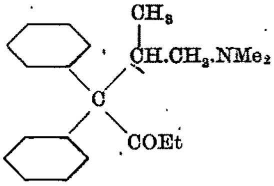

II


III

In view of the recently published work on the chemistry[3] and clinical trials[4] of *iso*amidone (III), it may be added that we have also prepared and examined this compound in the form of its nitrate.

The pharmacological properties of *d*- and *l*-amidone have been compared and are briefly reported in Table 2, together with some preliminary observations on *iso*amidone. These results are more accurate than our earlier observations[2], since the same methods were used with two dose-levels for each compound and a larger number of animals at each treatment.

The two experiments on analgesic activity referred to in the table were cross-over tests on rats arranged so that each rat had each treatment of drug and dose once over a period of several days. The first experiment was made on a total of eighty rats, and in the second forty rats were used. Morphine was used as the standard of comparison in each case.

It will be seen that the lævo-isomer is the pharmacologically active form. (Although an increase in pain threshold was observed after large doses of *d*-amidone, there was no well-established dose : response relationship, and hence this is not regarded as evidence of true analgesia. The reason for the toxic property of *d*-amidone is not yet known.)

The respiratory depressant activity was determined on 9–12 rabbits for each compound at two dose-

TABLE 1

Ref. No.	Compound	Melting points					$[\alpha]_D$ Base in alcohol	$[\alpha]_D$ Cation $RNMe_2H+$	
		Base	HCl	HBr	HI	HNO_3		in alcohol	in water
69C47	*dl*-nitrile	91	182	178	203	169	—	—	—
—	*l*-nitrile	100	—	215	199	176	− 51°	—	—
—	*d*-nitrile	101	—	216	—	—	+ 49°	+ 6°	− 7°
10820	*dl*-amidone	76	231	224	198	109	—	—	—
173C47	*l*-amidone	99	241	234	—	—	− 32°	− 169°	− 145°
193C47	*d*-amidone	99	240	234	175 dec.	148 dec.	+ 28°	+ 165°	+ 143°

TABLE 2

Compound	Analgesic activity				Respiratory depressant activity	
	Dose mgm./kgm.	Peak rise in pain threshold %		Activity ratio	Equi-active dose mgm./kgm.	Activity ratio
		Exp. 1†	Exp. 2†			
10820 (*dl*-Amidone)	2·4	61	—	1·3	2·5	1·4–2·0
	1·2	40	—			
173C47 (*l*-Amidone)	1·2	60	—	2·2	1·5	2·7–3·3
	0·8	30	—			
193C47 (*d*-Amidone)	20·0	33	—	$<0·1$*	$>30·0$	$<0·1$
	10·0	33	—			
Morphine	3·0	62	40	1·0	4–5	1·0
	2·0	43	22			
*iso*Amidone (442C47)	2·5	—	23	1·0	7–10	0·4–0·7
	1·5	—	16			

* See text note, p. 605.
† The two analgesic experiments are comparable with one another, since morphine was used as a standard of comparison in each case.

levels, but no effect was produced by *d*-amidone with doses comparable with those of the lævo-form. With a dose of 30 mgm./kgm. of *d*-amidone, approximately 30 per cent depression of respiration was seen.

Comparative experiments have been made with these compounds upon human volunteers, and the analgesic results in general resemble those given above for *d*-, *l*- and *dl*-amidone or morphine. The respiratory depressant action of *l*-amidone appears to be more than twice as great as that of *dl*-amidone, but *d*-amidone is almost without effect.

The toxic doses of the optical isomers of amidone upon intravenous injection in mice all lie between 15 and 18 mgm./kgm. for the L.D. 50 value, whereas the L.D. 50 for *iso*amidone nitrate is approximately 40 mgm./kgm.

In experiments upon the respiration of rat brain homogenate carried out by Dr. G. E. Glock, it was found that at concentrations of 0·005 *M*, *d*-, *l*- and *dl*-amidone produced similar degrees of inhibition of oxygen uptake of approximately 70 per cent. These results confirm those of Elliott[5] for amidone; but it should be pointed out that this concentration of drug is far greater than can be reached in the body after analgesic doses of these substances, and hence is of little practical significance.

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Acquired Resistance (Twofold) to Quinine in *Plasmodium gallinaceum*

AFTER the introduction of the newer synthetic antimalarials, the possibility of acquired resistance of plasmodium strains to these drugs became important, analytically and clinically.

Experiments to examine this question were started in April 1946. Naturally the communications by Bishop and Birkett[1] and by Williamson, Bertram and Lourie[2] were very interesting to me. In my series of experiments I started with quinine; then I tried to produce resistance to 'Paludrine', and I can confirm the possibility of resistance. Among the strains in my laboratory there is one (*Plasmodium gallinaceum*) which by administering seven times 4 mgm./kgm. 'Paludrine' weekly had acquired after some fifteen weeks a high degree of resistance to 'Paludrine'. In contrast with Williamson, Bertram and Lourie, I was able to produce in *Plasmodium gallinaceum* a moderate, nevertheless clearly demonstrable, resistance to quinine. My method was as follows: on Monday, blood inoculation (50 million parasites) in a 7-day-old chick. Oral administration of a minimum active dose of quinine once on Monday, twice on Tuesday, Wednesday and Thursday, totalling seven doses. On Friday the results were checked. On the following Monday, blood inoculation of the drugged strain, as on the previous Monday, etc.

To produce 40–50 per cent reduction of the percentage of infected erythrocytes, as compared to untreated control animals, a dose of 10 mgm./kgm. quinine-base (administered as hydrochloride) was found to be necessary; 20 mgm./kgm. (also administered seven times) caused nearly total reduction. These results agree with those of P. B. Marshall[3].

Originally 10 mgm./kgm. quinine was administered; after 12 weeks this dose failed to cause reduction. After 16 weeks the dose was increased to 20 mgm./kgm. Against this dose, too, there arose gradually (after a further sixteen weekly treatments) a resistance, so that it caused no reduction at all (see Table 1).

TABLE 1

Normal strain		Q 37	
Controls (undrugged)	Quinine, 20 mgm./kgm.	Controls	Quinine, 20 mgm./kgm.
81% (4) infected erythrocytes	0·9% (5)	78·7% (5)	75·2% (5)

Q 37 stands for 37 treatments with quinine, of 7 doses each.
The number of birds in each experiment is given in brackets.

These results were repeated several times.

The quantitative estimation of this resistance was very important. Extensive experiments showed the resistance to be twofold: in the quinine-resistant strain, 40 mgm./kgm. quinine produced about the same action as 20 mgm./kgm. in a normal strain (see Table 2).

The increase of quinine resistance (twofold) is rather small as compared to 'Paludrine' resistance (40-fold);

TABLE 2

Normal strain			Q 51		
Controls	Quinine, 20 mgm./kgm.;	40 mgm./kgm.	Controls	Quinine, 20 mgm./kgm.;	40 mgm./kgm.
87% (12)	0·3% (10)	0·2% (9)	79% (10)	78% (10)	0·4% (10)
				Q 53	
		30 mgm./kgm.		20 mgm./kgm.;	30 mgm./kgm.
77 % (8)		0·1% (10)	63% (9)	56% (6)	18% (10)

experiments have been begun to ascertain if quinine resistance might be increased.

The essential difference between my experiments and those of Williamson, Bertram and Lourie is the fact that they used very large doses (150 mgm./kgm. daily in 516 out of 870 days) as compared to my doses of 20, later 40 mgm./kgm. daily, with three drugless days every week. How this difference bears on experiments with mepacrine, sulphadiazine and 3349 (I.C.I.) remains to be examined.

A further series of experiments served to examine if resistance is maintained after passage through the mosquito (*Aedes ægypti*) (see Table 3).

TABLE 3

Normal strain		Q 55 (through mosquito)	
Controls	Quinine, 20 mgm./kgm.	Controls	Quinine, 20 mgm./kgm.
87% (5)	0·2% (10)	43% (9)	8% (10)

Repetition of these experiments had the same results. So after one passage through the mosquito, acquired resistance to quinine is partially lost, in contrast with the persistence of acquired 'Paludrine' resistance. As regards quinine, this result agrees with those of Kritschewski and Halperin[4] (*Plasmodium relictum*), if one interprets their tables correctly.

The quinine-resistant strain appeared to be non-resistant to mepacrine, 'Paludrine' and chloroquine, because minimal active doses were as effective in the quinine-resistant strain as in a normal strain.

At present I am experimenting on the reaction of the secondary cinchona alkaloids and other anti-malarials. Also series of related experiments (inoculation of *EE* forms, loss of resistance, etc.) are in progress.

A detailed account of my results will be published later. I am indebted to the Imperial Chemical (Pharmaceuticals), Ltd., for the gift of 'Paludrine', and to the Nederlandsche Kininefabriek for the specially purified cinchona alkaloids. I am also grateful to Dr. F. Hawking (National Institute of Medical Research) for introducing me to the modern technique with *Plasmodium gallinaceum* and for putting a strain at my disposal; also to Dr. D. G. Davey, who demonstrated his laboratory technique. The experiments were carried out with the technical assistance of Miss Ella Pauw.

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Freezing as an Aid in the Drying and Purification of Humus and Allied Materials

It is well known in colloid chemistry that the freezing of gels may cause coagulation, which is in some cases irreversible. We have found little evidence, however, that this phenomenon has been used to any great extent as a laboratory technique to simplify the bulk preparation of materials of a colloidal character.

In our work on soil organic matter, it is necessary to filter, reprecipitate and refilter frequently acid-precipitated flocculæ of humic acids (that is, materials allied to 'alkali-lignin' which constitute the bulk of soil organic matter). These materials, because of their large bulk, colloidal character and water-retaining capacity (greater than ten times their dry weight), are extremely difficult to filter and dry.

It has been found that, if the precipitates are frozen solid to a temperature of at least − 3° C. and then allowed to thaw, the colloidal properties are destroyed and the solid and aqueous phases separate. Moreover, the solid is in a condensed form, as irregular microscopic flakes, which are very readily filtered by standard methods.

The moisture content of a humus preparation has been reduced to one thirtieth of the original by a single freezing and thawing.

The colloidal character of the materials having been destroyed, they not only lose their water-holding capacity but also their general adsorptive power. Therefore, by washing with water, soluble contaminants are readily removed and a considerable degree of purification attained.

The presence of electrolytes is necessary for the freezing effect to take place, since in their absence the material reverts to its colloidal form on thawing.

The condensed humus can be regenerated in normal form by solution in alkali and precipitation with acid. The raw materials (soil, peat, or decomposed vegetable matter) are extracted with dilute (2 per cent) caustic soda and the alkaline extract acidified with sulphuric acid to a *p*H of approximately 3. The precipitated humus is allowed to settle, and after the supernatant liquor has been siphoned off, is frozen to − 3° C. It is then allowed to thaw, filtered, washed, and because of its small bulk and non-adsorptive powers is readily completely dried by standard methods.

The method is applicable to materials of similar properties such as 'alkali-lignin' precipitated from the waste liquors in the soda process, and may indeed have wide application in simplifying the preparation of plant structural substances in a readily handled form.

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Effect of Oxygen on the Frequency of Chromosome Aberrations Produced by X-Rays

MOTTRAM[1] demonstrated that the effect of gamma- and X-radiations in inhibiting the growth of *Vicia faba* root tips was materially reduced if the exposure was made under anaerobic conditions, and that the change in radiosensitivity could not be correlated with a change in the proportion of cells in division at the time of irradiation. Crabtree and Cramer[2] had previously shown a similar effect of anaerobiosis on the radiosensitivity of tumour cells.

We have confirmed Mottram's result by irradiating with X-rays (H.V.L. 1 mm. Cu) groups of beans with their roots in a 'Perspex' cell of water through which nitrogen was bubbled. The cell was placed in a cardboard box with small holes for the egress of the nitrogen to minimize back diffusion of air. The nitrogen was bubbled for ten minutes, the radiation was given in the next ten minutes, and the bubbling of the nitrogen, which had continued during the irradiation, was kept on for five more minutes. The beans were then returned to the culture tank, where they were always in darkness to avoid a daily mitotic rhythm. Doses of 320 r., 255 r., and 175 r. were given to three groups, while three other groups were treated identically, but air was bubbled instead of nitrogen. In no case did the temperature of the water drop by more than 2° C. from the 19° C. of the culture tank. The growth curves of the nine beans in a group have been averaged and are plotted in Fig. 1, which illustrates the striking effect of the anaerobiosis on the radiosensitivity.

Experiments are in progress here to test Gray's[3] hypothesis that the lethal effect of ionizing radiations on the growing tip of the *Vicia faba* root is due to the genetic abnormalities which result from the division of cells containing aberrant chromosomes. The results so far have been in agreement with this view, and it was therefore believed that the decrease in radiosensitivity of the root tips in nitrogen should be accompanied by a parallel decrease in the proportion of cells having chromosome aberrations. Groups of beans have therefore been irradiated, as described above, except that the exposure time was reduced to 4 min. to match earlier experiments. The dose was 143 r. In the case of half the groups nitrogen was bubbled, and for the other half oxygen (not air). Again the temperature did not drop by more than 2° C. Tips were fixed at intervals up to 72 hours after the exposure; Fig. 2 shows the percentage of anaphases in which there were visible bridges or fragments. All but two of the points are based on 100 anaphases studied in each of two root tips. The yield of chromosome aberrations is also strikingly less when the irradiation is done in an atmosphere of nitrogen. As a similar reduction of radiosensitivity, as measured by growth subsequent to irradiation, was observed when nitrous oxide, carbon dioxide, and hydrogen were substituted for nitrogen, it seems clear that the availability of oxygen is a very important factor in the production of chromosome aberrations. It is possible that the effect of temperature observed by Sax and Enzmann[4], and Catcheside *et al.*[5], and the effect of pH observed by Marshak[6] may, at least in part, be due to differences in the availability of oxygen. That the radiosensitivity of tumours is affected by oxygen supply has long been suspected. It now seems likely that this influence does act through the effect on the production of chromosome aberrations.

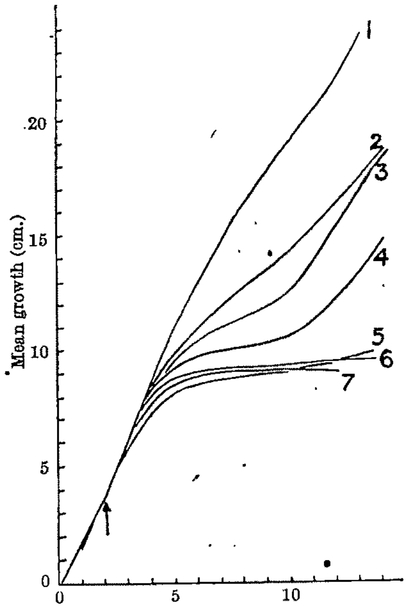

Fig. 1. EACH CURVE IS THE AVERAGE OF THE GROWTH CURVES OF A GROUP OF NINE ROOTS OF THE BROAD BEAN (*Vicia faba*) TREATED AS FOLLOWS ON THE SECOND DAY:

(1) 175 r. in nitrogen; (2) 255 r. in nitrogen; (3) 320 r. in nitrogen; (4) 175 r. in air; (5) 175 r. in oxygen; (6) 255 r. in air; (7) 320 r. in air

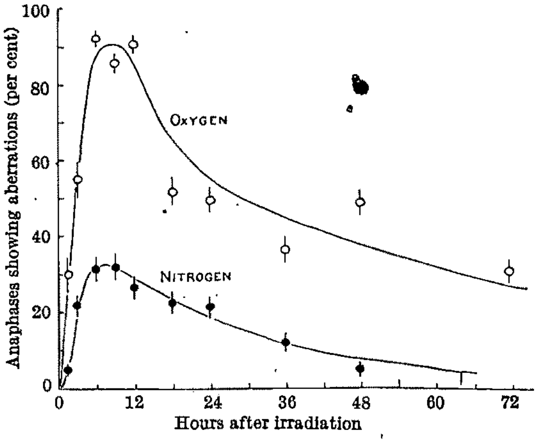

Fig. 2.

Upper curve—143 r. in oxygen; lower curve—143 r. in nitrogen

The details of these experiments and a full discussion will be published later. This preliminary report is given to direct the attention of those studying the production of chromosome aberrations by radiations to the importance of controlling the oxygen supply.

J. M. THODAY
JOHN READ

Mount Vernon Hospital and
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Northwood, Middx.
June 27.

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[1] Mottram, *Brit. J. Radiol.*, 8, 32 and 643 (1935).

[2] Crabtree and Cramer, Imperial Cancer Research Fund Report No. 11, 75 (1934).

[3] Gray, British Empire Cancer Campaign Annual Report (1942).

[4] Sax and Enzmann, *Proc. U.S. Nat. Acad. Sci.*, 25, 75 (1939).

[5] Catcheside, Lea and Thoday, *J. Genet.*, 47 (2), 397 (1946).

[6] Marshak, *Proc. Soc. Exp. Biol. and Med.*, 38, 705 (1938).

Initial Parenchyma Cells in Dicotyledonous Woods

STUDIES on living trees have shown that the concentric bands of parenchyma cells found in the diffuse-porous wood of *Terminalia tomentosa* W. and A.[1,2] are initial, that is, they are formed as the first tissues of a growth season. Some similarity between these parenchyma cells and those that occur in the early wood of ring-porous timbers was recognized, and in one specimen of *Terminalia tomentosa* W. and A.[2] a tendency to form semi-ring-porous structure was noticed, but nothing more than this was known at that time. Recently I have, however, come across some wood specimens of *Gmelina arborea* Roxb. which show not only both diffuse-porous and ring-porous structure but also some intermediate stages between these two extremes.

When *Gmelina arborea* Roxb. has a true diffuse-porous wood, the initial parenchyma cells may be altogether absent, although the growth rings may be visible due to the difference in the thickness of the fibre wall of early wood and that of the late wood of the previous year (Fig. *a*). In the first stage towards ring-porosity, the timber remains a diffuse-porous wood, but in between the early fibres and the late fibres of the previous year, a thin layer of initial parenchyma cells is usually present (Fig. *b*). This is exactly what was originally found in *Terminalia tomentosa* W. and A.[1]. At this stage, there may not be any appreciable difference between the size of the vessels within a growth ring, and the early vessel may not come in contact with the initial parenchyma cells. In the next stage, the timber has a semi-ring-porous structure. The somewhat large and scattered early vessels are partially embedded in the initial parenchyma cells. Finally, the timber shows a true ring-porous structure, where a clear row of large vessels are partially or wholly embedded in the initial parenchyma (Fig. *c*). Thus the part played by the initial parenchyma cells in the transformation of diffuse-porous wood to ring-porous wood is quite evident.

In tracing the development of initial parenchyma cells, it seems possible to detect some physiological cause for their formation. Forsaith[3] and Huber[4] have shown that rigour of growth condition is responsible for the formation of ring-porous timbers. It is therefore possible that *Gmelina arborea* Roxb. produces true diffuse-porous timbers when the growth conditions are mild, and semi-ring-porous to true ring-porous timbers when the conditions of growth are slightly to greatly severe. The capacity to vary its anatomical structure to suit the growth conditions would appear to be of a great help in maintaining its wide distribution.

Since the discovery of initial parenchyma cells in the wood of *Terminalia tomentosa* W. and A.[1], researches carried out at the Forest Research Institute, Dehra Dun, and elsewhere have shown that there are many diffuse-porous woods which have initial parenchyma cells; for example, *Dalbergia sissoo* Roxb.[5], *Swietenia macrophylla* King[6], *Salix matsudana* Koidz[7], and *Entandrophragma macrophyllum* A. Chev.[8]. On the other hand, some American workers[9] have questioned the validity of my original observations on *Terminalia tomentosa* W. and A. Based on some incomplete material collected from a few members of the Juglandaceæ, they were not able to decide whether to call these parenchyma cells terminal or initial. However, researches carried out in this laboratory have shown that the initial parenchyma cells are often a generic character and may in some cases be even a family character. Details of this investigation will be published elsewhere.

K. A. CHOWDHURY

Forest Research Institute,
Dehra Dun, India.
Aug. 9.

[1] Chowdhury, K. A., *Nature*, **133** (1934).

[2] Chowdhury, K. A., *New Phyt.*, **35**, 4 (1936).

[3] Forsaith, C. C., *Ecology*, **1**, 2 (1920).

[4] Huber, B., *Deutsch. Bot. Ges.*, **53**, 8 (1935).

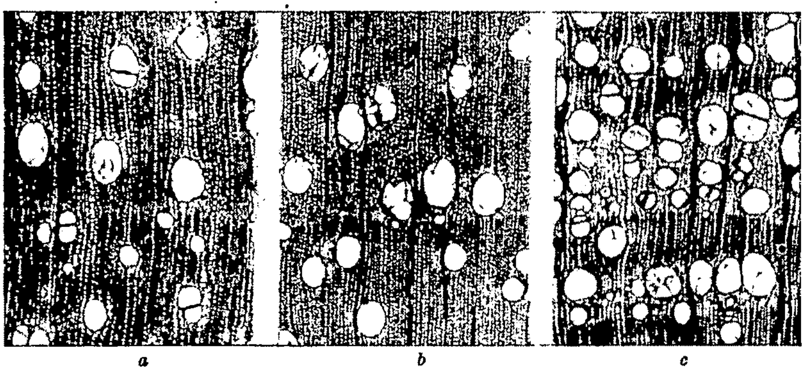
[5] Chowdhury, K. A., *Indian For. Rec.* (n.s.), (*Utilization*), **2**, 2 (1940).

[6] Chowdhury, K. A., *Indian For. Rec.* (n.s.), (*Utilization*), **2**, 3 (1940).

[7] Chang, Y., private communication (1936).

[8] Hummal, F. C., *Emp. For. Rev.*, **25**, 1 (1946).

[9] Heimsch, C., and Wetmore, R. H., *Amer. J. Bot.*, **26**, 8 (1939).



VARIATION IN THE RING-POROSITY OF *Gmelina arborea* ROXB. : (*a*) TRUE DIFFUSE-POROUS; (*b*) DIFFUSE-POROUS WITH INITIAL PARENCHYMA CELLS ; (*c*) TRUE RING-POROUS. × 20

Willow as Host-Plant of *Crioceris merdigera*

A SHORT note by Mr. Saulnier in *Miscellanea Entomologica*, **43**, July 1947, p. 43, is headed "L'osier est-il une nouvelle plante hôte de *Crioceris merdigera* Linné ? (Chrysomelidæ, Coleoptera)". On two occasions he has found this chrysomelid beetle on osier-willow (*Salix viminalis* L. Salicaceæ), once on July 6, 1943, at La Booz, near Bretoncelles, Orne, and again on April 28, 1946, at Berdhuis, Orne. At first he thought it was accidental, but having found it a second time a note asking the above question seemed justifiable.

In order to understand the relationships between the insect and its host-plants, it is necessary to consider the group as a whole ; the host-plants of a single species of beetle constitute a datum which cannot by itself suggest relationships. According to the tables in my book (not yet published) the largest number of the Criocerinæ occurs on species of Gramineæ and Liliaceæ. Criocerine beetles have also been found on plants of families Commelinaceæ, Dioscoreaceæ, Orchidaceæ, Salicaceæ, Solanaceæ, Cucurbitaceæ, Compositæ and nine others.

There is one record of a criocerine beetle (*Lema lichenis* Voet = *Lema cyanella* Suffr. = *Crioceris cyanella* L.) attacking willows (see Fowler, "Coleoptera of the British Islands", p. 282 ; 1890). Mr. Saulnier's find is further evidence in support of the principle that when one species of a group of insects has been found to occur on a plant, others of the group may also be expected to occur on it.

Although the particular species which Mr. Saulnier has found on a willow has not been reported from that host before, the occurrence is thus not altogether unexpected.

S. Maulik

British Museum (Natural History),
London, S.W.7. July 12.

Preparation and Properties of 3-Ethyl-5:5-dimethyloxazolidine-2:4-dione

It is stated by Spielman[1] that 3 : 5 : 5-trimethyloxazolidine-2 : 4-dione can be prepared by methylating 5 : 5-dimethyloxazolidine-2 : 4-dione in aqueous alkaline solution with dimethyl sulphate. Spielman failed to obtain the 3-ethyl analogue by this method using diethyl sulphate. A product, m.p. 61–62°, which was regarded as the 3-ethyl analogue, was, however, obtained by the action of ethyl iodide on the silver salt of 5 : 5-dimethyl-oxazolidine-2 : 4-dione.

It is now found that by treating the sodium salt of the dimethyloxazolidinedione in alcoholic solution with diethyl sulphate or with ethyl iodide, the 3-ethyl derivative is readily obtained. It melts at 76–77° and is not identical with the product obtained by the silver salt method. Thus the product, m.p. 76–77°, is stable to aqueous hydrochloric acid and with aqueous sodium hydroxide yields the sodium salt of N-ethyl-N-α-hydroxyisobutyrylcarbamic acid ; whereas the product, m.p. 61–62°, is unstable to hydrochloric acid, yielding the original 5 : 5-dimethyloxazolidine-2 : 4-dione and also to aqueous sodium hydroxide, yielding the sodium salt of the 5 : 5-dimethyloxazolidinedione.

The product m.p. 76–77° is regarded as being the true 3-(or N-)ethyl derivative, and that of m.p. 61–62° as an O-ethyl derivative of an enolic form of 5 : 5-dimethyloxazolidine-2 : 4-dione.

Further support for this view is found in the facts that the O-ethyl compound is readily converted to the N-ethyl compound by the action of heat and to the N-methyl, N-ethyl and N-*benzyl* derivatives when heated with methyl iodide, ethyl iodide and benzyl bromide, respectively.

Pharmacological tests carried out in these laboratories indicate that the 3-ethyl derivative is an anti-convulsant having an activity of the same order as that of the 3-methyl derivative.

W. H. Hook

British Schering Research Institute,
Brook Lane, Alderley Edge,
Cheshire. June 30.

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[1] Spielman, *J. Amer. Chem. Soc.*, **66**, 1244 (1944). See also B.P. 561183.

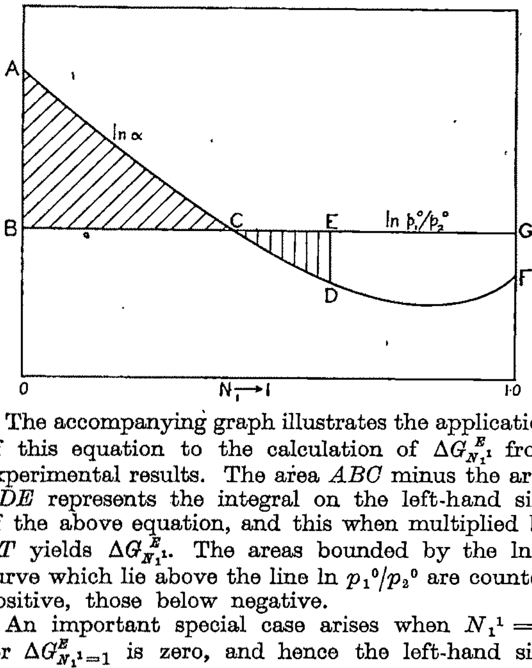
A Thermodynamic Test for the Internal Consistency of Experimental Data on Volatility Ratios

An important measurable parameter in the study of vapour-liquid equilibria in two-phase binary mixtures is the volatility ratio (α) defined by $N_1^g.N_2/N_1.N_2^g$, where N_1^g is the mol fraction of component 1 in the vapour and N_2^g that of component 2, while N_1 and N_2 are the corresponding quantities for the liquid. In view of the difficulties inherent in the determination of α, the need for a thermodynamic test of the reliability of experimental data has been expressed[1]. In this note such a test will be described and also a method given for deriving ΔG^E from the curve of α plotted against N_1, where ΔG^E is the excess free energy of formation of the mixture over an ideal mixture of the same composition. A study of this quantity (ΔG^E) is fundamental to the investigation of the structure of liquid mixtures.

The considerations will be restricted to the case where the vapours may be treated as ideal gases and where the molar volumes of the liquids may be neglected in comparison with that of the vapours. The expression can readily be modified to remove these restrictions, but when they are applicable it can be shown that equation (1) holds for isothermal conditions.

$$RT\int_0^{N_1^1}(\ln \alpha - \ln p_1^0/p_2^0)\,dN_1 = \Delta G^E_{N_1^1}, \qquad (1)$$

In this equation p_1^0 and p_2^0 are the vapour pressures of the pure components at T° absolute and $\Delta G^E_{N_1^1}$ is the excess free energy of formation of the mixture containing N_1^1 mols of component 1.



The accompanying graph illustrates the application of this equation to the calculation of $\Delta G^E_{N_1^1}$ from experimental results. The area *ABC* minus the area *CDE* represents the integral on the left-hand side of the above equation, and this when multiplied by *RT* yields $\Delta G^E_{N_1^1}$. The areas bounded by the ln α curve which lie above the line ln p_1^0/p_2^0 are counted positive, those below negative.

An important special case arises when $N_1^1 = 1$ for $\Delta G^E_{N_1^1=1}$ is zero, and hence the left-hand side of equation (1) is also zero, that is, the algebraic area bounded by $N_1 = 0$ and $N_1 = 1$ and the curves ln α and ln p_1^0/p_2^0 is zero when the above convention as to sign is employed. Thus, in order that the data shown in the graph should be thermodynamically consistent (subject to the above restrictions) it is necessary that area *ABC* should equal area *CDFGE*.

In practice, the ln α against N_1 curve has to be extrapolated to $N_1 = 0$ and $N_1 = 1$, which can usually be done with little error. The areas may be found either with the aid of a planimeter or by quadrature.

This test for the internal consistency of data refers strictly only to values found under isothermal conditions, but may be usefully applied in a semi-quantitative manner to isobaric data if the components are a close-boiling pair. Here the values of ln p_1^0/p_2^0 appropriate to the boiling point of the mixtures are plotted against N_1. The equation applicable to isobaric data when the components differ considerably in boiling point is rather more complex.

The derivation of equation (1) and examples of its use in the investigation of the systems thiophene – benzene and ethylene dichloride – benzene will be published elsewhere.

I am indebted to Dr. R. P. Linstead, director of the Chemical Research Laboratory, for permission to publish this note.

E. F. G. Herington
Chemical Research Laboratory,
Teddington, Middlesex.
July 11.

[1] Carlson and Colburn, *Ind. Eng. Chem.*, **34**, 1533 (1942).

Hydrodynamics of Non-Newtonian Fluids

If the assumption is made that a fluid is incompressible, then the most general possible relations between the stress components ($t_{xx}, t_{yy}, \ldots$) and the strain-velocity components ($a, b, \ldots$) can be obtained as

$$t_{xx} = 2\Theta . a + 2\Psi . A' + p \ldots,$$
$$\text{and} \quad t_{yz} = \Theta . f + \Psi . F' \ldots \quad (1)$$

($a, \ldots f, \ldots$) are given, as in classical hydrodynamics, by

$$a = \partial u/\partial x \ldots \text{ and } f = \partial v/\partial z + \partial w/\partial y \ldots,$$

where (u,v,w) are the components of velocity at a point (x, y, z). ($A_1', \ldots F_1', \ldots$) are given, in terms of ($a, \ldots f, \ldots$), by the relations

$$A' = a^2 + \tfrac{1}{4}(g^2 + h^2) \ldots$$
$$\text{and} \quad F' = \tfrac{1}{2}gh + (b + c)f \ldots \quad (2)$$

p is a hydrostatic pressure. Θ and Ψ are arbitrary functions of the strain-velocity invariants K_2 and K_3, where

$$K_2 = ab + bc + ca - \tfrac{1}{4}f^2 - \tfrac{1}{4}g^2 - \tfrac{1}{4}h^2$$
$$\text{and } K_3 = abc + \tfrac{1}{4}fgh - \tfrac{1}{4}af^2 - \tfrac{1}{4}bg^2 - \tfrac{1}{4}ch^2.$$

The invariant $K_1 (= a + b + c)$ is zero, since the fluid is incompressible.

The stress *vs.* strain-velocity relations (1) are somewhat similar to those obtained by Reiner[1] for a compressible fluid.

For a Newtonian fluid, $\Psi = 0$ and Θ is a constant—the viscosity of the fluid. For a non-Newtonian fluid, Θ depends on the strain-velocity invariants K_2 and K_3. It appears, from (1), that for a general, incompressible fluid, there is a second physical parameter Ψ which must be specified in order to define completely the flow properties of the fluid. This, again, may be a constant, or may depend on the strain-velocity invariants K_2 and K_3.

Equations (1) have been applied to calculate the forces which must be exerted on the boundary surfaces of a general, incompressible fluid in the following two cases.

(i) A cylindrical mass of fluid is subjected to a single torsional motion, in which each point of the fluid moves in a circular path about the axis of the cylinder, in a plane at right-angles to it, its angular velocity ψz being proportional to its distance z from one end of the cylinder.

(ii) A mass of fluid is contained between two coaxial cylinders, which are rotated with respect to each other about their common axis, and each point of the fluid moves in a circular path about this axis, in a plane at right-angles to it, with an angular velocity Ω, which depends only on the distance from the axis.

In case (i), it is found that in order to produce the specified motion of the fluid, both azimuthal and normal surface tractions must be exerted on the plane ends of the cylinder. If Ψ is constant, then the normal surface traction Z which must be exerted at a point at a distance r from the cylinder axis is given by

$$Z = \tfrac{1}{4}\Psi\psi^2 (3r^2 - a^2), \quad (3)$$

where a is the radius of the cylindrical mass of fluid.

In case (ii), it is found that in order to produce the specified motion of the fluid, azimuthal surface tractions must be exerted on the cylindrical surfaces of the fluid, and normal surface tractions Z must be exerted on the plane-free surfaces. If Ψ is constant, the value of Z at a distance r from the common axis of the cylinders is given by

$$Z = -2\Psi(\Omega_1 - \Omega_2)^2 \left(\frac{a_1^2 a_2^2}{a_1^2 - a_2^2}\right)^2 \frac{1}{r^4}; \quad (4)$$

a_1 and a_2 are the radii of the inner and outer confining cylinders and Ω_1 and Ω_2 are their angular velocities.

In the calculations of both cases (i) and (ii) it is assumed that centrifugal and gravitational effects can be neglected. It is seen, from (3) and (4), that if $\Psi = 0$, $Z = 0$ for both systems. The effects which arise from the non-vanishing of Ψ are similar to those obtained by Weissenberg[2] with a variety of fluids. It does not appear, however, that his explanation of these effects can be a valid one, since it depends on the presence of an elastic component in the stress *vs.* strain relations for the fluid, which could not make itself evident in any experiment on steady-state flow. From the point of view of phenomenological theory, such effects can arise in a material which is not visco-elastic. Whether or not materials which show this effect are, in practice, visco-elastic is a matter which must be decided either on experimental grounds or by studying the dependence of Ψ and of rigidity on the constitution of the fluid.

This work was carried out as part of a programme of fundamental research undertaken by the board of the British Rubber Producers' Research Association, while I was a guest worker at the National Bureau of Standards, Washington, D.C. It is hoped to publish a fuller account elsewhere.

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Welwyn Garden City,
and
National Bureau of Standards,
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[1] Reiner, M., *Amer. J. Math.*, **67**, 350 (1945).

[2] Weissenberg, K., *Nature*, **159**, 310 (1947).

A Long-Term Plan for the Nile Basin

In an article on "The Nile Basin", vol. 7, in *Nature* of August 16, p. 215, Dr. C. E. P. Brooks directs attention to the fact that the theory underlying what we have called 'century storage' is not given in the book. This was omitted because it was thought better not to make a book dealing with Nile projects more difficult by including in it complicated theoretical investigations. It is the intention to publish a full account of these separately; but it may be opportune to give here a very short summary of what has been done, and also to clear up a point raised by Dr. Brooks as to the correctness of the formula: $R = 1{\cdot}65\,\sigma\sqrt{N}$, on which our scheme of projects depends. This relates to a set of N observations the frequency distribution of which is approximately Gaussian when no account is taken of their order, σ being the standard deviation and R the maximum accumulated excess or deficit of departures from the mean. In the case of a river discharge, R is the amount of storage required to meet accumulated deficits over a period N. The equation gives the mean value of R obtained from 71 sets of observations of river discharges, river levels, rainfall, temperature and pressure covering periods of from thirty to two hundred years, with two or three cases outside this range, and a mean period of 97 years.

The form of the equation was obtained by considering the case of tossing a set of coins N times when the result is equal numbers of heads and tails. The frequency distribution is approximately Gaussian for a set of ten or more coins. If there fall n heads and n tails, the number of orders in which this can occur is $2nCn$. Among these orders there are $2nCn+h$, in which at some point heads exceed tails by h or more (Whitworth, "Choice and Chance"). By giving h all values from 0 to n, a mean value for the maximum excess of heads over tails can be found. Using Stirling's approximation for $n\,!$ we find:

$$R = \sqrt{n\pi} = \sigma\sqrt{\tfrac{1}{2}N\pi} = 1{\cdot}25\,\sigma\sqrt{N}.$$

This is a first approximation and was verified practically by tossing 10 sixpences 1,000 times, with the following results:

N	Number of sets	Mean value of $R/\sigma\sqrt{N}$
100	10	1·11
500	2	1·26
1,000	1	1·19

It is to be noted that owing to approximations the above result does not hold for small values of N.

The investigation relates to sequences of chance events where there is no relation between one member and another. Meteorological elements, however, often show periods when, on the whole, values are high, and others when they are low. The tendency of this grouping is to give higher values for R than those found for purely chance distributions, and is the explanation of the difference between the mean values of 1·25 and 1·65 for $R/\sigma\sqrt{N}$ found for chance events and natural phenomena.

The variation of R with N for natural phenomena was examined, but the lack of records covering long periods made it impossible to distinguish practically between $R \propto N$ and $R \propto \sqrt{N}$, so the form arrived at for chance events was naturally adopted. Dr. Brooks agrees that the difference between the two formulæ is not serious from a practical point of view, and actually it is much less than he has calculated from the incomplete data on the diagram in the book.

Some discussions with Dr. W. Lawrence Balls had directed attention to a fundamental theoretical question arising out of the investigation; that is, what are the statistical properties of natural phenomena such as river discharges, rainfall, etc., having regard to their order of occurrence? Dr. Brooks' remarks lead also to this question. So far as the practical affair of water storage, which led to the investigation, is concerned, we have given a satisfactory solution which covers periods up to one or two centuries. It is this solution which has enabled us to draw up for the first time a detailed scheme of irrigation projects for the full development of Egypt and the Sudan. The scarcity of records covering several centuries and the mathematical difficulties have, however, so far prevented us from giving a complete theoretical solution, though work is continuing on this. Dr. Brooks has kindly supplied us with a series for 4,000 years of the thickness of annual mud deposits in Lake Saki, and the examination of these and of the Carnegie Institution data about tree rings may lead to interesting results. References to other long series of observations would be valuable to us.

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R. P. BLACK
Y. M. SIMAIKA

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Cairo.

The Missing Factor in Science

PROF. H. DINGLE, in his inaugural lecture at University College, London[1], has done me the honour of coupling my name with that of the late Sir Arthur Eddington as horrible examples of distinguished thinkers "making statements of the greatest import which even an intelligent child can see to be directly contradicted by the facts".

Unfortunately the statement ascribed to me that science is "the means of obtaining practical mastery over nature through understanding it" represents such a gross distortion of my expressed attitude towards the question that I cannot let it pass without protest. As any reader of my book[2] can see for himself, I have held that this view only represents one aspect of science which has to be taken account of in assessing the total significance of science. Though it is impossible to condense adequately the significance of such a complex activity as science in a few sentences, the following quotation from my final chapter does expose the superficiality of Prof. Dingle's judgment:

"We have seen science as an integral part both of the material and economic life of our times and of the ideas which guide and inspire it. Science puts into our hands the means of satisfying our material needs. It gives us also the ideas which will enable us to understand, to coordinate, and to satisfy our needs in the social sphere. Beyond this science has something as important though less definite to offer: a reasonable hope in the unexplored possibilities of the future, an inspiration which is slowly but surely becoming the dominant driving force of modern thought and action."

If I had said—which I have not—that science was *nothing but* "the means of obtaining practical mastery over nature", Prof. Dingle might justly reproach me with omitting many other weighty aspects. Curiously enough, this is not what he tries to do. Instead, he sets himself the impossible task of proving that science is not concerned with such mastery. It is therefore not surprising to find that of the four simple tests which he uses to disprove my alleged definition, the first and last are false, the second irrelevant and the third unscientific.

It is clearly not the acceptance criterion of scientific papers that can be expected to show the purpose of science, but their content and the aim revealed in each investigation. In the very copy of *Nature* in which this article appears there are nineteen communications of original research; of these no less than ten are directly concerned with the mastery of man over nature, as for example a letter on "Disease of Pyrethrum in Kenya", and all the remainder, with the possible exceptions of "Feeding Mechanisms of Water Bugs" and the "Individual Activities of Ants", are examples of "understanding of nature" only one remove from practical requirements. Lest this should be thought a reflexion on the purity of *Nature*, an examination of the last two numbers (1020 and 1021) of that most austere of scientific publications, the *Proceedings of the Royal Society* (A), shows an even greater proportion—11 : 8—of papers directly devoted to the mastery of nature. The criterion of acceptance of these papers is that they should be, as far as may be judged by competent men, significant and accurate, for these are necessary though not sufficient conditions for the effectiveness of action based on them.

Equally unreliable is Prof. Dingle's last criterion of the achievements of the recipients of prizes and medals. It is only necessary to look at the citations to see how often the value of the new knowledge to humanity is stressed.

As to Prof. Dingle's second criterion, the questions in the examination papers, it has nothing to do with the argument. However much we may deplore it, examinations to-day are designed to test competence and knowledge, not purpose.

It is the third criterion that is most surprising, particularly coming from Prof. Dingle, for it is neither more nor less than his old bugbear—the appeal to the authority; and not even to that of the fathers of the Church, of the founders of the Royal Society—but to the literary authors of the New English Dictionary. Neither they nor the authorities from which they collected their readings had any object beyond the fixing of commonly accepted meanings. When the compilation is done again, undoubtedly the new definition of science as "mastery over nature" will be cited, though I hope it will be attributed to Prof. Dingle and not to me.

Now it would not have been worth writing this letter if it was not for the fact that the very disagreement between Prof. Dingle and myself over definitions and proofs is the strongest argument for the need to provide for the undertaking of criticism of science which Prof. Dingle urges in the latter part of his address. I may find his arguments as feeble and wrongheaded as he finds mine childish and tragic, but we both agree that the question is important and that we must train, pay and honour those who devote themselves to an attempt to answer it.

We need a recognition of a science of science, of which the study of the history of science will provide the initial descriptive base, but which itself is pursued like other sciences by research and experiment. The motives, incentives, methods and organisation of science all need study by research teams. The sooner we realize that such investigation is as good science as any other, the sooner we shall cease to waste our time in muddle and controversy and get on with the job of science, whatever it may be found to be.

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[1] *Nature*, 160, 108 (July 26, 1947).

[2] "The Social Function of Science", by J. D. Bernal (Routledge, 1939).

I AM very glad indeed to know that Prof. Bernal supports my plea for criticism in science, and only slightly less so to learn that he disowns the view of science I ascribed to him. My article would have been worth writing for these results alone.

He implies, however, that I have distorted his previous writings; but re-reading confirms the first impression, which is not modified by the passage now quoted. Science is there described as an integral part of economic life and as offering a vague hope for the future, and this hope is presumably what he now emphasizes. But I was speaking of what science *is*, not of the many things it may be held to 'offer'. Unfortunately, lack of space demanded severe abridgment of my lecture, and I would ask those who feel that certain passages need qualification to read the full text just published by Messrs. H. K. Lewis and Co. It shows my awareness that science *can be used* for material ends, and Prof. Bernal's statement that I try to prove that science is "not concerned" with mastery over nature is, therefore, misleading. Our difference is perhaps best revealed by his statement that the criterion of acceptance of papers is significance and accuracy, "for these are necessary . . . conditions for the effectiveness of action based on them". I hold that the criterion is "significance and accuracy" irrespective of whether action can be based on them or not.

I cannot accept Prof. Bernal's criticism of my tests for the nature of science. I still maintain that the "acceptance criterion" and not "content and aim revealed" (in so far as these are separable from the acceptance criterion) is the proper clue to the meaning of science; indeed, it seems to me obvious. *Nature* is not the kind of journal I mentioned. I do not agree with Prof. Bernal's analysis of the last two numbers of the *Proceedings of the Royal Society* (A), but I am astonished that, after declaring that "the history of science will provide the initial descriptive base" of the study of science, he should base his own arguments on the last two numbers of the *Proceedings of the Royal Society*, and the next edition of the New English Dictionary. I did not expect to find him so "deceived by the momentary appearance of a movement which after taking 2,000 years to prepare itself, has been gathering momentum for the last 300 years". It would surely not be surprising if, after several years in which all scientific effort was perverted to a particular end and kept secret, the early succeeding papers should show an abnormal possibility of practical application, though I maintain again that that would not be why they would be accepted for publication and, therefore, would not be the clue to the 'science' in them.

Finally, I am puzzled to know why Prof. Bernal, while acknowledging that the New English Dictionary merely gives "commonly accepted meanings", should charge me with "appealing to authority" by referring to it. I turned to it for "commonly accepted meanings", assuming that, if Prof. Bernal's book was to be trusted, the "mastery over nature" view should be there. His book states (p. 6) that that view (now described as "new" and attributable to me) was present in classical times, appears explicitly in Roger Bacon and at the Renaissance, and is fully expressed in its "modern" form by Francis Bacon. "This," he adds, "remained the predominant view of science for at least two hundred years." Why is it not mentioned in the Dictionary, and why will it "undoubtedly" appear next time ?

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VALVE WITH TROCHOIDAL ELECTRONIC MOTION

By Prof. H. ALFVÉN and H. ROMANUS

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IN a homogeneous magnetic field an electron with a velocity perpendicular to the field moves in a circle. If an electric field is applied perpendicularly to the magnetic field, the circle 'drifts' with a velocity which to a first approximation (electric field not too strong) is

$$\mathbf{v} = -\frac{c}{H^2}\mathbf{H} \times \mathbf{E}.$$

The combined motion is a cycloid or trochoid. As the drift is perpendicular to the electric field, the circle in which the electron moves is displaced along *an equipotential line.*

If a beam of electrons moving in cycloids or trochoids is produced, this beam follows that equipotential line on which it started. As in a valve an equipotential line is easily changed and can be given almost any desired shape, a trochoidal beam possesses a high flexibility and can be used for many technical purposes, for example, the construction of electronic switches and counters.

During recent years research on valves with cycloidal or trochoidal electronic motion has been carried out at this laboratory. The development of the valves, which are called 'trochotrons', has been carried out by G. Hambraeus and, especially, T. Wallmark. Different circuits for the valves have been worked out by Lindberg, Lundquist, Warring and Åström.

The type of valve mostly used at present is shown diagrammatically in Fig. 1.

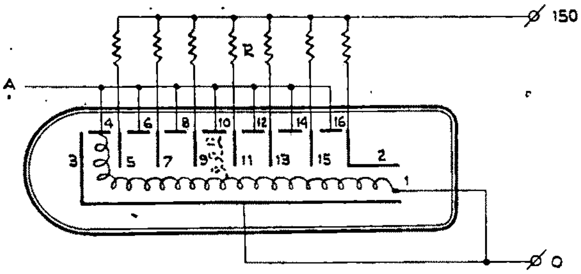

Fig. 1

A homogeneous magnetic field (100–200 gauss) is applied perpendicular to the plane of the paper. The filament 1 emits electrons which are attracted by the anode 2. Due to the magnetic field, however, they never reach the anode. Instead, a trochoidal beam is formed travelling along an equipotential line of the electric field formed between the electrode 3, which is held at zero or negative potential, and the electrodes 4–15, normally given positive potentials of 100–200 volts. The whole current emitted (about 1 mA.) is thereby received by the 'plate' 4.

If the potential of one of the electrodes 5, 7, 9, 11, or 13 (the 'guides'), for example, that of 9 is decreased to about 20 volts or lower, the equipotential line followed by the beam enters the box between 9 and 11. The current goes to plate 10, and in part also to guide 9. If this is connected to the voltage supply through a resistance R, the voltage drop in R will maintain the low potential on the guide. Consequently, if once *the beam is brought into a certain box it remains locked up there.* In other words, the electron beam of the valve has the peculiar quality that it is attracted to an electrode having a certain voltage, but diverted from the same when the voltage is decreased or *increased.* This implies a negative slope in one part of the voltage-current characteristic of all the electrodes in the valve, that is, every electrode may under certain voltage conditions act as a negative resistance. The characteristic of an electrode is shown in Fig. 2, where AB represents a series resistance, giving the locking position C.

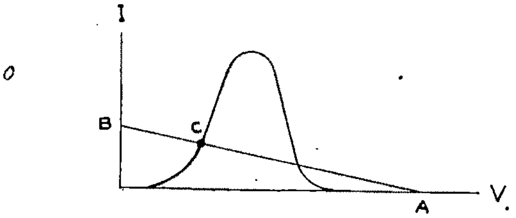

Fig. 2

The great flexibility of the trochoidal electron beam also makes it possible to use 'two-dimensional' electrode systems as in Fig. 3. If all electrodes except 0 are held at a high positive potential, the current goes to the plate 00. It may be switched, for example, to the plate 21 by putting the vertical guide 2 and the set of horizontal guides 1′ under zero voltage.

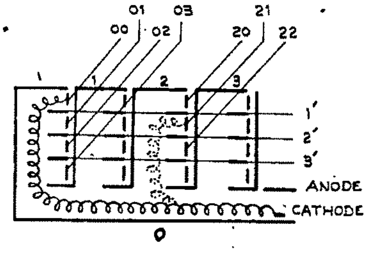

Fig. 3

A 10-box valve (see Fig. 1) is preferably used as an electrical counter ('scale-of-ten'). The pulses to be counted should be negative. They are applied to A, which is normally held at about 100 volts. Suppose that the beam at the beginning is landing on plate 4 in the first box. A decrease of the potential of this plate will displace the beam towards guide 5. Due to the resistance R in series with this electrode, the potential of 5 will immediately drop, so that the beam is brought into the second box. The next pulse will displace the beam from plate 6 to guide 7, which through a potential drop transfers the beam to the third box and so on. Finally, on arriving at guide 15, the beam is transferred to anode 2, and the anode potential will drop in the same way due to a series resistance, with the result that the emission from the cathode is cut off for a moment. Hence the initial conditions are restored so that the beam again goes to plate 4. Thus the valve may be operated as a cyclic switch. From the anode or one of the guides, every tenth of the input pulses may be tapped to another scale-of-ten unit or to a mechanical counter. Neon lamps in series with the plates may be used to indicate the actual position of the beam.

In this way the trochotron is used in electric counters and chronoscopes. It seems also to be a useful unit in calculating machines. A system for pulse-time modulated multiplex telephony has also been worked out, in which the valve is used as a cyclic switch and modulator or demodulator simultaneously.

Detailed reports of the investigations are in preparation.

INDEXING PRACTICE: TRENDS IN GERMAN, AMERICAN AND BRITISH CHEMICAL SOCIETIES' PRACTICE

By R. BRIGHTMAN

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MOST organic chemists have found in literature searches that the tracing of entries relating to particular compounds may be difficult because of inconsistencies in indexing practice. For example, although in the introduction to the Collective Index 1923–32 to *British Chemical Abstracts* there is given a list of substituents such as amino-, chloro-, nitro-, etc., which in the Index are placed immediately after the remainder of the name, whether or not the substituent group is preceded by di-, tri-, etc., and although the name of the individual compound commences with that substituent, previous practice had varied. In earlier volumes "Nitrotoluene", for example, may be found under "Toluene, nitro-", "Nitrotoluene" or "Paranitrotoluene", with or without appropriate cross-references. Again, in one volume, "Nitrochloronaphthalene" appears as well as "Naphthalene-, nitrochloro", but "Tetranitronaphthol, α-", is given only under "T", whereas "Trichloroacetic acid" appears under "Acetic acid, trichlor-". Disregarding variations in spelling, "paranitroaniline" is indexed under "P" (Paranitroaniline), under "A" (Aniline, p-nitro-) and under "N" (Nitroaniline, p-), and the nitrotoluidines under "Aminotoluene, nitro", under "Nitro-toluidines", under "Toluene, nitroamino" and under "Toluidines, -nitro".

It is not surprising that consistency in indexing should grow slowly; and the present time may even be one of maximum confusion, due to the continual increase of potential morasses through the expansion of technical chemistry, as a comparison of college text-books of organic chemistry of the last thirty to forty years will illustrate. None the less, the present inconsistencies imply that, to be sure of finding all references to a chemical compound from the Indexes to the abstracts issued by the Chemical Society or the Society of Chemical Industry, one would require to scan the Indexes not only under the name of the present compound but also under all the possible variations in arrangement of parts of the name, and this without systematic guidance from the Index itself.

Such circumstances have induced a preliminary study of indexing practice of *British Chemical Abstracts*, the *Chemische Zentralblatt*, and *Chemical Abstracts*. In this study, the results of which are here presented, the comprehensiveness with which the literature is covered, questions of cost or other points of economics, interval between the appearance of the original paper and the abstract, and the qualifications of indexing staff, have not been considered. The prime purpose has been a comparison of the three systems in practice in regard to the indexing of chemical compounds, and, as a sample, the indexing of some typical compounds, namely, butadiene, the butylene glycols and ethylene glycol over the last fifty years was examined.

Ethylene Glycol

Chemische Zentralblatt. In the Index to the 1897 volume this compound is entered under "Glykol". "Äthylen Glykol" appears in the Collective Index for 1897–1901, but there is no cross-reference to or from "Glykol". A similar remark applies to the 1899 Index. In the 1900 Index, "Glykol" is used as a generic term. Separate entries appear under both names in the 1901 Index, while from 1905 onwards entries under "Glykol" are differentiated by formulæ. In 1906 and subsequent Indexes there is a cross-reference from "Glykol" to "Äthylen Glykol", but the Collective Indexes 1897–1921 contain entries under "Äthylenglykol" with a cross-reference "Glykol see Äthylenglykol". In the 1922–24 Collective Index this practice is reversed. Entries are placed under "Glykol (Äthylenglykol)" with an entry "Äthylenglykol—See Glykol", and in the 1925–29 Index the entries under "Glykol" are classified in the usual manner under "preparation, physical properties, chemical properties". Thereafter entries are consistently placed under "Glykol" with cross-reference "Äthylenglykol—See Glykol".

British Chemical Abstracts. The Indexes to the Chemical Society's *Abstracts* for 1897 and 1898 contain the entry "Ethylenic Glycol", and in 1899 there is the cross-reference "Glycol, see Ethylenic Glycol". During 1900–13 this becomes "Glycol. See Ethylene Glycol", and entries are placed under "Ethylene glycol". The latter term is the sole entry in the Indexes for 1915–17 and 1920–26, but in 1918 and 1919 the cross-reference "Glycol. See Ethylene glycol" is again given, and also in the Collective Indexes, 1903–12, 1913–22, 1923–32 and 1933–37 and the Annual Indexes to *British Chemical Abstracts* from 1927 onwards, with the exception of those for the years 1934–36 and 1943–44, when the cross-reference from "Glycol" is dropped although the entries are still placed under "Ethylene glycol".

Chemical Abstracts. In the Indexes to the 1907–9 volumes there are entries under "Ethylene glycol" and "Glycol" with no cross-reference. In 1910 there are entries under "1 : 2-Glycol" but none under "Ethylene glycol". In 1911 "Glycol" only is entered, and in the following year both "Ethylene glycol" and "Glycol" appear without cross-reference: the entries under "Glycol" in this year (1912) relate to derivatives. Entries in 1913 and 1914 are similar, but in 1915 under "Glycol" there is entered "See also Ethylene Glycol". In 1918 under "Glycol" is entered the note: "Individual glycols not having a common name, e.g., glycol, are indexed under the Geneva name, e.g., Propanediol". This note is repeated in 1919 and afterwards. The same volumes contain the entry "Ethylene glycol. See Glycol. For derivatives see 1 : 2-Ethanediol, 1 : 2-Propanediol, etc.", and this is repeated at intervals down to 1944.

Butylene Glycol

The indexing of butylene glycol in the period 1901–44 presents a similar picture. In the *Chemische Zentralblatt*, entries are made both under "Butylen glykol" and "Butandiol", and only in 1919 is there a cross-reference "See Butylen glykol" under "Butandiol". But from 1922 onwards entries under

"Butandiols" and "Butylen glykols" are transferred to the Formula Index.

In *British Chemical Abstracts* and *Chemical Abstracts*, entries are made both under "Butylene glycol" and "Butane diol", frequently without cross-reference; and although the tendency in *Chemical Abstracts* from 1918 onwards is to enter under "Butane diol" in accordance with the note already quoted under "Ethylene glycol"—"Individual glycols not having a common name, e.g., glycol, are indexed under the Geneva name, e.g., Propanediol"—the Index to the volume for 1920 contains the entry "Butane diol. See Butylene glycol".

Butadiene

Chemische Zentralblatt. "Butadiene" first appears under that name in the 1897–1901 Collective Index. The Index to the volume for 1903 contains an entry under "Erythren" but nothing under "Butadiene". In the 1902–6 Collective Index all three names, "Butadiene", "Erythren" and "Divinyl", are entered, but there are no cross-references. There is a reference under "Erythren. See Divinyl" in the 1911 Index, but "Butadiene" is entered separately with no cross-reference. In the index to the second volume for the same year, "Butadiene" and "Erythren" are entered separately with no cross-reference or to "Divinyl". In 1912 there is an entry under "Erythren" and a cross-reference "Butadiene. See Erythren". In 1913 "Divinyl" and "Erythren" are entered separately for the first half-year, and in the second half-year there are entries "Butadiene" and "Erythren" but with no entry for "Divinyl". The Indexes for 1914 and 1915 contain entries for "Butadiene" and "Erythren" but no cross-reference; and in 1916 there are entries under "Divinyl" and "Erythren" but not under "Butadiene", and there are no cross-references. Similarly, the entries in 1918 under "Divinyl" and "Butadiene" are without cross-references; and also in 1919 under "Butadiene" and "Erythren" and in 1921 under "Butadiene". The 1912–15 Collective Index refers from "Butadiene" to "Erythren" and *vice versa*, but there is no reference from either to "Divinyl", which is entered without a cross-reference. In the 1917–21 Collective Index, "Divinyl" and "Erythren" are both entered without cross-reference and there is no entry under "Butadiene". In the following Collective Index (1922–24) there are entries "Erythren. See C_4H_6", "Butadiene. See C_4H_6", but there is no entry under "Divinyl". In the next Collective Index (1925–29) all three names are referred to the Formula Index.

British Chemical Abstracts. Much the same variations are found in the *Abstracts* of the Chemical Society and in *British Chemical Abstracts*. In 1899 the entry "Divinyl. See Butinene" occurs, while "Butinene (Divinyl)" is also entered. In 1901 the following entries are made:

> "Butinene (Ethylacetylene),
> Butinene (Crotonylene, dimethylacetylene)";

but there is none under "Butadiene", "Divinyl" or "Erythrene". "Butadiene" appears in 1904, and in 1905 in addition to "Butadiene" and "Erythrene" there is the entry "Butinene. See Erythrene". "Butadiene" alone is entered in 1906, "$\Delta^{\alpha\gamma}$-Butadiene" in 1907, "n-Butinene" in 1909, and "Butadiene" and "Erythrene" in 1912. In 1913 there are the following entries: "Erythrene", "$\Delta^{\alpha\gamma}$-Butadiene", "Δ^{α}-Butinene", "Δ^{β}-Butinene. See Crotonylene". In 1914 there are entries for "Butadienes", "$\Delta^{\alpha\gamma}$-Butadiene", "Δ^{α}-Butinene" and "Erythrene" but no cross-references; in 1915 "Butadiene"; in 1916 "Divinyl" and "Erythrene" (without cross-reference); in 1917 "Divinyl"; and in 1923 "Butadienes" only. In 1924 "Butadiene", and "Δ^{γ}-Butinene $CH_2 : CH.CH : CH_2$" are entered, while the Collective Index 1923–32 gives "Butadiene", "$\Delta^{\alpha\beta}$-Butadiene", "$\Delta^{\alpha\gamma}$-Butadiene", "Butadienes", "Erythrene (See also Hydrocarbons, erythrene)", "Divinyl"; but without other cross-references. The Collective Indexes, 1903–12 and 1913–22, similarly give all three terms without cross-references. Similar inconsistencies persist in the annual indexes down to 1940. Some years one term is used and in others another, with no cross-reference in either volume. For example, in 1926, both "Butadiene" and "Erythrene" appear; in 1930 "Butadiene" and "Divinyl"; while in 1934 all three are entered. "Divinyl" appears again in 1937 and 1938, but not afterwards. "Erythrene" is only entered again in 1939 and thereafter entries are under "Butadiene" or "$\Delta^{\alpha\gamma}$-Butadiene", but without cross-references.

Chemical Abstracts. "Butadiene" first appears in the Index to *Chemical Abstracts* in 1911, and in 1912 "Butadiene", "Divinyl" and "Erythrene" are all entered. In 1913 "Butadiene" and "Erythrene" are entered; all three appear in 1914 and 1915; but not until 1916 are there cross-references, when "Divinyl" is made the main entry and "Erythrene" and "Butadiene" are entered with the note "See Divinyl".

This practice, however, was not adhered to rigorously, for in 1918 there are entries under "Butadiene" but not under "Erythrene" or "Divinyl", and the entry "Bivinyl" and the cross-reference "Butadiene. See Bivinyl" do not appear until 1921. In 1922 "Butadiene" and "Divinyl" are entered, but not "Bivinyl" or "Erythrene". In 1923 "Butadiene. See Bivinyl" is again entered, but the only entry under "Erythrene" is "Erythrene, αα-dimethyl—See 1 : 3-Pentadiene, 4-methyl-". In 1925 there is the entry: "Bivinyl (erythrene) (for derivatives, see under 1 : 3-butadiene, etc.)" and also "Erythrene, see Bivinyl", both of which are repeated in 1926. The entry "Divinyl, see Bivinyl" is not repeated in 1926, although this volume includes the entry "1 : 3-Butadiene, see Bivinyl".

The indexing appears to become more systematic from 1927 onwards, though the editors appear to be unable to make up their minds which name to adopt as the main entry. Thus in 1927 we find "1 : 3, Butadiene, see Bivinyl"; "Erythrene, see Bivinyl"; "Bivinyl (Erythrene). For derivatives see under 1 : 3-Butadiene, etc.", and in 1928 "Divinyl, see Bivinyl". In 1931, however, there are no entries under "Divinyl" and "Erythrene", and under "Bivinyl" is entered "see 1 : 3-Butadiene". There are no cross-references from "Butadiene". Again, although in 1934 and 1935 "Bivinyl" is entered "see Butadiene", and "Butadiene (bivinyl)", there are no entries or cross-references for "Divinyl" and "Erythrene". In 1937 there is entered "Bivinyl (Erythrene), see also Butadiene"; "1 : 3-Butadiene, see also Bivinyl"; "Divinyl, see Bivinyl"; "Erythrene, see Bivinyl". In 1938 "Bivinyl" is entered "see 1 : 3-Butadiene"; but although bivinyl is given in brackets after "Butadiene", there are no entries under erythrene or divinyl. In 1941 "Butadiene" is entered "See also Di- under Olefins" and "Olefins, di-", "See also Rubber substitute and synthetic". In 1942–44 butadiene is entered "Butadiene (Bivinyl).

See also "Rubber substitute and synthetic" and in "Di-" under "Olefins".

These examples indicate that while cross-referencing in the indexes to *Chemical Abstracts* is no more systematic than in *British Chemical Abstracts*, it is somewhat more complete. What is more impressive, however, when the indexes are compared, is the extent to which the editors of *Chemical Abstracts* have from the start attempted to define precisely the indexing policy followed and to modify this from time to time to incorporate any practice on which some general international agreement has been reached. For example, in 1938–40 the nomenclature and indexing for inorganic compounds was modified in accordance with the recommendations of the report of the German Commission (*Helv. Chim. Acta*, **20**, 159; 1937) and the rules of the Commission on the Reform of the Nomenclature of Inorganic Compounds (*Ber.*, **73A**, 53; 1940; *J. Chem. Soc.*, 1404; 1940); while in 1935 Crane's modified Broughton system was brought into use for deuterium compounds (*Ind. Eng. Chem., News Ed.*, **13**, 200; 1935). In the 1938 Index the practice used in botanical and zoological nomenclature is also defined, and the authorities used for insects, for bacteria, and for alloys are specified.

The practice followed in indexing organic compounds is described in detail in prefaces to the indexes to successive volumes, notably in those for 1917, 1927, 1937 and 1945, and the Collective Indexes for 1907–16 and 1917–26. The basis of this has been the system of organic chemical nomenclature described by A. M. Patterson and C. E. Curran (*J. Amer. Chem. Soc.*, **19**, 1623; 1917), and the most striking change in the indexing methods is the inversion of all names containing substituent prefixes, "Chloroacetic acid", for example, being now placed under "Acetic acid, chloro-". This is in keeping with the principle laid down in the preface to the 1918 volume that subjects, not words, are indexed; but the idea of arranging alphabetically on the basis of the parent compound was taken from the *Journal of the Chemical Society*, although it was not until the 1923–32 Collective Index that the practice was systematically adopted in *British Chemical Abstracts*. Afterwards, in 1937, some changes were made towards the adoption of the Rules given in the Definitive Report of the International Committee on Organic Nomenclature (*J. Chem. Soc.*, 1607; 1931; *J. Amer. Chem. Soc.*, **55**, 3905; 1933; cf. also C. Smith, *J. Chem. Soc.*, 1067; 1936). Although there is nothing to indicate the fact in prefaces to *Chemical Abstracts* or *British Chemical Abstracts*, according to a paper by E. J. Crane (*J. Chem. Educ.*, **8**, 1335; 1931) in 1923 the Nomenclature Committee of the Chemical Society, London, and that of the American Chemical Society, agreed on the rules covering some of the more commonly disputed points, including some of significance for classification.

In contrast to this it is difficult to trace definite evidence that any of these reports on organic or inorganic nomenclature or on the nomenclature of deuterium compounds have been adopted in British practice. Apart from a brief preface to the Collective Indexes for 1883 and 1892, according to which the index is in the main alphabetical, but wherever practicable substances are arranged alphabetically and under such well-defined main groups as alkaloids, carbohydrates, glucosides, etc., there is no further preface or explanatory note until the Collective Index for 1923–32, when the practice already noted of placing certain substituent groups after the remainder of the name is adopted. Some indication as to indexing practice may be found in the "Instructions to Abstractors" which are sometimes to be found bound with the *Abstracts*, although I have not been able to trace an issue earlier than 1918. Much of this, and indeed the use as standard of reference of the Collective Indexes of the Chemical Society, 1913–22 and 1923–32, involves the translation of names used in American and other chemical periodicals, to fit rather a set of rules than a defined system or set of principles.

From this preliminary survey certain tentative conclusions can be drawn.

(1) *Chemical Abstracts* represents the most persistent attempt to provide adequate alphabetical indexing of chemical compounds by name; but even in current practice, room for considerable improvement can be seen.

(2) Both in *Chemical Abstracts* and in *Chemische Zentralblatt* there can be seen a distinct trend towards a formula index for indexing definite organic chemical compounds, in view of variations in chemical nomenclature and to allow for compounds not named by their originators.

(3) There is some evidence of a trend towards agreement on nomenclature between the British and American Chemical Societies, but progress in this direction is unlikely to be rapid and the general adoption of an international system by all chemists is a remote probability, even disregarding the fundamental difference of mother tongues.

(4) Independently of the question of coverage and of the economic aspects of abstracting, on the basis of circulation and resources, it is now improbable that *British Chemical Abstracts* could ever hope to compete with *Chemical Abstracts*; nor has this survey revealed any reason for making the attempt.

(5) The law of scattering deduced by the late Mr. E. Lancaster-Jones in an investigation instigated by Dr. S. C. Bradford (cf. *Engineering*, **137**, 85; 1934; also *Rep. Proc. 14th Conf. Assoc. Spec. Lib. and Inform. Bur.*, 1937, pp. 59–71; and *F.I.D. Comm.*, **13**, 61–65; 1946) suggests that the best means of securing complete cover is not by rival abstracting organisations, but by functional co-operation and laying out the field by sciences on some such basis as the Universal Decimal Classification.

The most important development to be desired appears to be the standardization of indexing practice, probably on the basis of formulæ rather than names, and the establishment of some central body with adequate resources to provide comprehensive annual and decennial, or other periodic indexes, as may be most convenient, for English-speaking chemists. Since reports from Germany (cf. *Ind. Eng. Chem., News Ed.*, **24**, 790; 1946) suggest that the future of the *Chemische Zentralblatt* is highly uncertain, this appears to be the most urgent need and much more essential than the question of abstracting. If any financial resources can be set free for the purpose by elimination of redundant abstracting, that might strengthen the case for Government assistance if required. Since, however, the provision of such comprehensive indexes would be of great assistance to industrial research in particular, it should not be difficult to make out a strong case in the first instance for support by industry as well as by the State.

ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION

THE ninety-second annual exhibition of the Royal Photographic Society has this year, for the first time, been held in two sections on view at different times. It will be recalled that last year the whole exhibition was displayed in a gallery at the Science Museum, London, at the same time as the special exhibition commemorating the centenary of photography. This year the exhibition has returned to the Society's House at 16 Prince's Gate, London, S.W.7, and the experiment has been tried of division in time to permit both sections more space. Part 1, which was pictorial in outlook, was shown first, and was followed by Part 2, which had a scientific outlook. The lantern slides, colour transparencies and stereoscopic exhibits, most of which belonged to Part 1, were shown for the whole period of the exhibition.

The scientific section was as usual dominated by the natural history exhibits, which are well up to standard in quality as well as quantity. By far the majority of exhibits are photographs of birds in their natural surroundings, and we can but admire the ingenuity and patience that enables the photographer to approach such timid creatures sufficiently closely to produce such fine photographs. Two exhibitors received the Society's Medal for their entry. High-speed flash photography has been used to produce some remarkably interesting records of birds in flight. A redstart is photographed in various attitudes when approaching to alight on a twig and illustrates well the use of the wings as a brake. Perhaps the most remarkable high-speed photograph is that of a tawny owl flying towards the camera with a mouse in its beak. The movement has been arrested and the bird is in perfect focus, though it can be seen from the ground that the depth of field is relatively small. One wonders whether this was secured by perfect timing or whether some tripping device was used. Of all the exhibits, which in addition to birds included insects and flowers, it may be said that most of them, as well as providing a record, have artistic merit of their own and can be enjoyed by the physicist and chemist as well as by the ornithologist and botanist.

The next largest entry was in the so-called Record Press and Commercial Section. This always seems a little out of place among the scientific and technical exhibits, consisting, as it invariably does, mainly of photographs of carvings in churches, abbeys and other ancient buildings. However, recent experience during the years of destruction should have taught us the great value of records of the kind shown, and if such recording could be placed on a firmer scientific foundation, the results would be of even greater value.

The Scientific Section was quite well represented, but one cannot help comparing it unfavourably with the display at the Science Museum last year. There were forty-four exhibits, mainly photomicrographs. Of special merit was the exhibit awarded the Rodman Medal, illustrating in a series of six photomicrographs the development of the brittle starfish (*Ophiothrix fragilis*). The following is an extract from the catalogue: "It is believed that this is the first time that the development of a brittle-star has been illustrated by photography of the living larvæ. The various stages were obtained from the plankton, transferred to filtered sea water and photographed, without narcotization, under dark-ground illumination, a variety of objectives and eyepieces being used. Exposures were generally about one-fifth of a second."

There was an interesting series of photographs of triangular markings on the natural surface of a diamond crystal. These markings are often deep with steep sides, and the series consists of photomicrographs illustrating the patterns produced with the crystal surface in contact with an optical flat. The depth and contour of the sides of the hollow can be better interpreted by the use of unfiltered mercury light than by monochromatic light. The high-speed exhibit, which has for years introduced something new and interesting, was disappointing, though it contained one of the most remarkable pictures in the whole exhibition. It is entitled "Milk Bar" and was photographed during a milking operation when a fine jet of milk was directed horizontally. This jet of milk was incident normally on the end of a cat's nose, the cat having reared up on its haunches in order to reach the stream. The expression on the cat's face defies description. This photograph was submitted in this section on the somewhat ingenuous excuse that it illustrates the fact that the jet of milk is divided into droplets. Whatever we may say on the subject of suitability of subject-matter, no human selection committee could possibly have rejected this photograph.

Finally, in order of number of exhibits, came the Medical Section. This contained sixteen exhibits including the 'before and after' type illustrating the results of plastic surgery, photographs of surgical specimens, and clinical photographs.

STANDARDIZATION IN INDUSTRY

"THE History and Philosophy of Standardization" might serve as a descriptive title for the main theme of the presidential address of Mr. Percy Good delivered before the Institution of Electrical Engineers on October 9.

From the simple beginnings with weight, length and volume standards already recognized in antiquity as necessary concomitants of trade in and between civilized communities we have erected, in modern times, a vast and complex structure of standards and codes of practice to meet our present-day needs. "Just as it became necessary", said Mr. Good, "from the earliest trading days to have standards for comparing or measuring quantity so, to-day, when in a very large number of cases weight, area or volume have no significance in determining the suitability or value of a product, standards are required to enable the properties which are significant to be assessed in comparable terms." The industrial standards employed to-day comprise the following classes: standards of quality, fitness for purpose or performance; dimensional standards; standard methods of sampling, and certification marking; terms, definitions and symbols (nomenclature).

Referring to dimensional standards, which have as a primary purpose the securing of interchangeability and the establishing of a range of types, experience during the War provided instances in which requirements could be met by types numbering perhaps dozens where hundreds or even thousands of types had previously been manufactured. Each industry should investigate the economics of dimensional standardization from the points of view of interchangeability and the elimination of unnecessary types and sizes. Commenting upon the refusal of the English-speaking countries to abandon completely the traditional and instinctive methods of subdivision in favour of the metric system, Mr. Good remarked : "This characteristic compromise is due partly to an intuitive recognition that there is much reason behind tradition and partly to an intuitive selection from alternatives of the one which most facilitates thinking processes. It perhaps also illustrates an unconscious resistance to the view that the scientist is always right and should have the last word."

Assessment of the quality of a commodity in bulk by the process of sampling is an inheritance from early trading practice which only in recent years has been developed and applied in manufacturing industry on a sound scientific basis. This development has rendered practicable the use of certification marks on goods where testing must, for one reason or another, be carried out on samples. A notable example of the successful use of a certification mark, in association with a manufacturer's mark, is the hall-marking of gold and silver articles, a practice introduced in Britain more than six hundred years ago.

The standardization and the co-ordination of the technical terms employed in science and in industry are not inconsiderable factors in the conduct of trade with efficiency and probity. The possibility of international as well as national co-operation in the introduction and definition of new technical and scientific terms is, in Mr. Good's opinion, a matter meriting the attention of the Institution of Electrical Engineers.

In the development of electrical standards, the work of the British Association in 1861 on the fundamental units was followed by the setting up in 1885 of a committee of the Institution of Electrical Engineers to prepare standards for electrical materials and appliances. This Committee was, shortly after the turn of the century, to merge its activities with those of the standardizing committees of the other professional engineering institutions in Britain to form the organisation now known as the British Standards Institution. From its inception as a body concerned with engineering standards, this body has developed into an organisation embracing within its scope practically every form of industrial activity and enabling all sections of industry to co-operate in the preparation of standards. The ideal standard should include requirements in terms of the mechanical, physical and chemical properties which can be assessed objectively ; but many of our present standards necessarily include estimations of a subjective character. The progressive elimination of such indefinite measures of quality or performance is one of the important branches of research in relation to standardization.

Reviewing the position of the electrical industry as a whole, Mr. Good remarked that he had watched its growth first from the inside and later from an external position in which he had been able to compare progress with that of other industries. "As a result", he said, "I am convinced of the truth of S. Z. de Ferranti's statement, made in 1910 and referred to in last year's presidential address, that wherever coal or gas is used for the production of heat or power, everything for which it is used would be better done were electricity the medium of application." That there will be an enormous increase in the use of electricity is certain. The electrical industry in Britain is, however, in common with others, faced with the need for planning for its future development. "This year", he went on, "has seen an Act of far-reaching importance come into being. In my opinion there is no substantial case against some form of public control of the generating and distribution side of the electrical industry, nor indeed against national control of any public service where competition is unwarrantable. This section of the industry should, however, be confined to generating and distribution and should not be permitted to manufacture the machinery or equipment it uses. A very different type of mind is required for the generating and distribution side than is required for the manufacturing side, for those responsible for running machinery and equipment have to be satisfied with it for many years, whereas the maker should be temperamentally desirous of improving his product. Moreover, a great deal of technical progress is made as a result of what might be called the 'competition' that goes on in the designer's mind in his desire to make progress."

"We are", said Mr. Good, in concluding this section of his address, "inheritors of the result of the thinking of our predecessors, and we must see to it that when our successors look back they do not detect any flagging in our efforts to give humanity the benefits that electricity alone can bring."

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 3

Royal Society of Medicine, Epidemiology and State Medicine Section (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Dr. E. Ashworth Underwood : "History of Cholera in Great Britain" ; Major-General Sir John Taylor : "Current Problems in Cholera Control" ; Mr. P. Bruce-White : "Bacteriological and Immunological Aspects of Cholera".

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Symposium on "Intelligence Testing in School and Work".*

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. C. Smart : "Industrial Organisation as a Factor in Production Efficiency".

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 6 p.m.—Mr. A. Walton : "The Artist in Relation to Textiles".

Tuesday, November 4

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Hon. Camilla Wedgwood : "Trading and the Exchange of Goods on Manam Island".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S. : "The Vegetation of the Chalk", 2. "The Biological Features of the Chalk Down Flora and their relation to the Physical and Biotic Factors".

Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. L. Rotherham : "The Selection of Stainless Steels for the Chemical Engineering Industries".

Institute of Physics, Electronics Group (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. H. Pratt : "Infra-Red Image Converters".

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 5.30 p.m.—Sir Roger Hetherington : Presidential Address.

Institution of Mechanical Engineers, Automobile Division (at Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—M. A. Jullien : "Independent Suspension Systems".

Sheffield Metallurgical Association (joint meeting with the Iron and Steel Institute, at 198 West Street, Sheffield), at 7 p.m.—Mr. C. Sykes, F.R.S., Mr. H. H. Burton and Mr. C. C. Gegg : "Hydrogen in Steel Manufacture" ; Prof. J. H. Andrew, Mr. H. Lee, Mr. H. K. Lloyd and Mr. N. Stephenson : "Hydrogen and Transformation Characteristics in Steel".

Wednesday, November 5

Institute of Fuel (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. Donald Hicks : "The Coal Resources of the Country".*

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Harry Lindsay : "Cultural Relations within the British Commonwealth".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. G. D. Reynolds : "Tests for the Selection of Components for Broadcast Receivers".

Society of Public Analysts and other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Scientific Papers.

Manchester Metallurgical Society (at the Engineers' Club Albert Square, Manchester), at 6.30 p.m.—Mr. E. Jones: "Electrical Strain Gauges".

Royal Statistical Society, Birmingham Group of the Industrial Applications Section (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. L. T. Wilkins: "Methods of Forecasting and Preventing Accidents".

Institute of Welding, Manchester and District Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. H. E. Lardge: "Welding in the Development of Jet Propulsion Engines".

Society of Instrument Technology (joint meeting with the Society of Glass Technology, in the Lecture Theatre, Science Museum, South Kensington, London, S.W.7), at 7 p.m.—Discussion on "The Instrumentation of Glass Tank Furnaces" (to be opened by Mr. H. L. Crooks and Mr. C. H. Stone).

Thursday, November 6

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Special General Meeting to consider a proposal by Council for the alteration of Statute 23; Dr. H. R. Ricardo, F.R.S.: "Some Problems in connexion with the Development of a High-speed Diesel Engine" (Bakerian Lecture).

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. N. Cock: "Electric Traction on the Southern Railway".

Chemical Society (in the Chemistry Lecture Theatre, University College, Nottingham), at 6 p.m.—Prof. F. S. Spring: "Some Contributions of the Organic Chemist to Biological Science".

Illuminating Engineering Society, Manchester Centre (joint meeting with the North-Western Branch of the Institution of Electronics, in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Dr. J. N. Aldington: "The Evolution of an Electric Lamp".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the South-West Essex Technical College, Forest Road, Walthamstow, London, E.17), at 7.30 p.m.—Scientific Film Display.

Chemical Society (in the Chemical Department, The University, Woodland Road, Bristol).—Prof. R. D. Haworth, F.R.S.: "The Oxidation of Phenols".

Friday, November 7

Association of Applied Biologists (in the Botany Lecture Theatre, Imperial College of Science, South Kensington, London, S.W.7), at 2.15 p.m.—Dr. A. C. Evans: "The Biology of Earthworms and their Effects on the Soil".*

Bedson Club (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. H. Bassett: "Pages from the Chemistry of Aluminium" (Sixty-seventh Bedson Lecture).

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Telephone Cable Measurements" (to be opened by Mr. S. Hanford).

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Discussion on "The Measurement of the Temperature of Sliding Surfaces, with particular reference to Railway Brake Blocks" (to be opened by Dr. R. C. Parker and Dr. P. R. Marshall).

Royal Statistical Society, London Group of the Industrial Applications Section (joint meeting with the Institution of Engineering Inspection, at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. D. Newman: "Acceptance Inspection with special reference to Sequential Methods".

Geologists' Association (at the Geological Museum, Exhibition Road, London, S.W.7), at 6.30 p.m.—Annual Re-Union.

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Discussion on "Surface Activity".

Society of Chemical Industry, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Prof. E. C. Dodds, F.R.S.: "Academic Research and the Chemical Industry".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "Foam".

Chemical Society (joint meeting with Cambridge University, in the University Chemical Laboratory, Cambridge).—Prof. C. N. Hinshelwood, F.R.S.: "A Problem in Chemical Kinetics".

Saturday, November 8

Physical Society (in the Physics Department, University College, Nottingham), at 10 a.m.—Scientific Papers.

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. A. L. Curtis: "Modern Tar Distillation Plant".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Laboratory Steward to take charge of the maintenance of the teaching and research laboratories of the Chemistry Department—The Bursar, The University, Sheffield (November 8).

Lecturer in Chemistry (Ref. F.886/47A), and a Lecturer in Physics (Ref. A.391/47A), at the Royal Aircraft Establishment Technical College, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (November 8).

Principal of the Luton Technical College—The Director of Education, Shire Hall, Bedford (November 8).

Lecturer in Mechanical Engineering—The Principal, Brighton Technical College, Brighton 7 (November 8).

Teacher in Biology at Canterbury Technical College and County Technical School for Boys—The Education Officer, 78 London Road, Canterbury (November 8).

School Psychologist—The Director of Education, Education Department, Pontmorlais, Merthyr Tydfil (November 8).

Lecturer in Mathematics, and a Lecturer in Chemistry, at the North Gloucestershire Technical College—The Clerk to the Governors, The Lypiatts, Lansdown Road, Cheltenham (November 8).

Senior Research Officers (2) with the Social Survey Division of the Central Office of Information—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting G.471/47A (November 10).

Principal of the Technical College to be established in Chippenham—The Director of Education, County Hall, Trowbridge, Wilts, endorsed 'Chippenham Technical College' (November 10).

Agricultural Economist, and Assistant Agricultural Economists (2, Grade B), to work under the direction of the Provincial Agricultural Economist at Newton Abbot—The Registrar, The University, Bristol 8 (November 10).

Research Chemist for work on soils, with headquarters at Auchincruive—The Secretary, West of Scotland Agricultural College, Blythswood Square, Glasgow C.2 (November 14).

Assistant Lecturers in the Department of Physiology (one will be mainly concerned with Histology)—The Registrar, The University, Liverpool (November 15).

Research Fellow to work in the field of intermetallic friction under conditions of plastic deformation in metal-working processes—The Professor of Industrial Metallurgy, The University, Edgbaston, Birmingham 15 (November 15).

Research Officers (2) in the Division of Electrotechnology, Sydney—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1402 (November 22).

Principal Scientific Officer or Engineer I at the National Gas Turbine Establishment under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2027 (November 28).

Lecturer or Assistant Lecturer in Zoology (preferably with special knowledge or qualifications in Vertebrate Zoology)—The Registrar, University College, Southampton (November 30).

Principal Scientific Officer in the Armament Design Department (Unguided Rocket Design Group), a Principal Scientific Officer in the Armament Design Department (Central Technical Group), and a Principal Scientific Officer or Senior Scientific Officer in the Armament Research Department, under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2024 (December 5).

Electrical Engineers for the Electricity Department of the Malayan Union—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Senior Lecturer in Agriculture, and a Resident Assistant Lecturer in Agriculture, at the Cumberland and Westmorland Counties' Farm School, Newton Rigg—The Director of Education, 5 Portland Square, Carlisle.

Senior Assistant Lecturer in the Department of Mechanical Engineering—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Lecturers in (*a*) Chemistry to B.Sc. standard, (*b*) Physics to General Degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Graduate Assistant Master for Physics, with subsidiary Chemistry and Mathematics, at the County Technical School—The Director of Education, County Education Offices, Newtown, Montgomeryshire.

Lecturer in Economic Theory, and an Assistant Lecturer in Psychology—The Registrar, University College, Nottingham.

Fisheries Research Officer (male or female) in Uganda—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Histologist, an Embryologist, a Neuroanatomist, and a Professor of Physiology—The Medical Secretary, Hebrew University, Jerusalem, Palestine.

Senior Nutritionist or Dietist, and Laboratory Technicians (including animal attendants)—The Director, Wellcome Laboratory of Human Nutrition, Churchill Hospital, Oxford.

Technician to take technical charge of laboratory and the training of junior technicians—The Secretary, Bacterial Chemistry Research Unit, Lister Institute, Chelsea Bridge Road, London, S.W.1.

Research Worker for investigation on African Trypanosomes at Field Station near St. Albans—The Director, Department of Parasitology, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Research Assistant with qualifications in physiology or zoology, at the Gerontological Research Unit—Dr. Korenchevsky, University Museum, Oxford.

Vice-Principal (woman, with qualifications in Education or Psychology), and a Lecturer (part-time, man or woman) in Biology—The Principal, City of Leicester Training College, Humberstone Drive, Leicester.

Mechanical Engineer in the Public Works Department, Tanganyika Territory—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Executive Engineer for the Public Works Department, Nigeria—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

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COMMUNICATION OF INFORMATION AND KNOWLEDGE

ALTHOUGH the meeting of the British Association at Dundee illustrated fairly enough, as it was planned to do, the great contribution which science can make to the task of building a better and a more stable world, there was easily discernible some even deeper thinking about the central issues that confront governments and peoples to-day. Some of the addresses, notably that of Prof. Dennis Robertson to Section F (Economics and Statistics), frankly challenged complacent and woolly thinking about planning and its limitations, while the presidential address itself touched on some deeper issues. When Sir Henry Dale suggested that there might be danger to science from a tendency to transfer too easily and completely, to the activities of peace, the attitude to research and the traditions of its conduct which have been acquired during six years of war experience, he was probably not thinking solely of the need of extending the fundamental investigations suspended or restricted by war, or of the trammels of scientific communication imposed by the obligations of secrecy.

Behind that plea for less secrecy and greater freedom of communication lies the much larger question of communication of knowledge in general. The threat to freedom of communication in science is only real in so far as conditions exist which threaten freedom of communication in general, and some of the sectional discussions at Dundee put this question of communication in its true light. It is a first condition of social cohesion and an essential factor in effective co-operation. It is more than the connective tissue of society; it is the nervous tissue as well.

That was well illustrated in the discussions on operational research in war and peace, on incentives in industry, and on public opinion surveys; and neglect of this factor has contributed seriously to the difficulties of Great Britain at the moment. In no department of administration has the Government more signally failed than in this matter of public relations. In one measure after another, it has not sought to secure, before introducing new measures, the full public understanding and support which are essential for the success of legislative or administrative action alike; and what the Government has not done itself, it has indirectly if not deliberately hindered the Press from doing. Few things, indeed, show up more clearly the consequences of the restrictions on newsprint than the contrast between the treatment by the Press of the Dundee meeting of the British Association and that of the last full meeting of the Association before the War. Limitations of space have prevented any reporting at all of numerous important discussions, and in consequence the educative value of the meeting has been more severely restricted to those present than at any time in the last century.

It is a further sign of the Government's ineptitude in the matter of communication, in spite of lip-service to the support and spread of scientific knowledge, that this moment should be chosen to re-impose the licensing system for the import of books; a measure which proved such a serious handicap to scientific and technical men during the War. Leaving on one side for the moment the consideration of the cultural aspect of this hindrance to the interchange of ideas and thought, at a time when the United Nations Educational, Scientific and Cultural Organisation is endeavouring to remove such obstacles, the restoration of a licensing system will put a new obstacle in the way of research workers obtaining the tools they need. Government policy, as well as the consequences of our own war effort, have concentrated the production of new scientific and technical books in overseas hands, largely in the United States; consequently, an immediate and indirect effect of the new Board of Trade order will be to hinder the increased industrial efficiency and development which the Government wishes to promote.

Such checks on discussion and communication are, in fact, much more serious than the limitations imposed by secrecy obligations, for example, in regard to atomic energy. No one can suggest that, in this field, Great Britain or the United States can disregard the implications of the new law in the U.S.S.R. regarding official activities; but in the atomic energy field it is the risk of administrative stupidity or incompetence in the administration of the Atomic Energy Act that lies at the root of any real fears as to its effect on the interchange of scientific knowledge, as distinct from the technical information relating to military applications. No well-informed person to-day will support the suggestion that the great bulk of industrial research work that is of scientific interest is not now published. British industry is now in no way behind American industry in this respect. It might even be held that it is in advance, in that more discrimination is exercised and negative results of no scientific significance do not clutter the pages of British scientific periodicals. The limiting factor is not the restraint on publication exercised by the industrial firm, but the reluctance or inertia of the scientific worker himself in the matter of preparing his results for publication before proceeding with further investigations.

Although, therefore, the secrecy threat to freedom of communication in science is apt to be overstressed, it cannot be denied that the existence of the new Russian law on the disclosure of State 'secrets', with its wide implications and restraints over the whole of industry, agriculture, science and technology, is liable to provoke Government intervention in other countries also, and so hinder the full development of science. That is true in the United States no less than in Great Britain; science thrives best under the conditions of full freedom of thought and discussion which best enable us to draw collectively upon all the resources of wisdom, statesmanship and goodwill which we possess.

Some recent publications of the American Academy of Political and Social Science are of interest and importance in this connexion for the positive suggestions they contain. For example, a paper by Dr. Sumner H. Slichter, "Some Economic Consequences of Science" (*Ann. Amer. Acad. Pol. and Soc. Sci.*, 249, 99; 1946) directs attention to the importance of extending our knowledge of techniques available for diminishing controversy and increasing the use of co-operative attacks upon problems, and of the conditions which determine the capacity of individuals to participate intelligently in the affairs of the community and to supervise effectively their representatives responsible for making and executing policies. Progress in these two fields would enormously increase the capacity of the community to serve its problems and to adjust itself to changes. The formulation of specific programmes in these fields is the task of the social scientist, and Dr. Louis Wirth also contributes a valuable paper on the "Responsibility of Social Science", in which he discusses the reasons for the failure of social science to gain wide public acceptance, and reports on the conditions required to enable research in social science to make its full contribution to the solution of problems arising out of the impact of science upon society. Significantly enough, Dr. Wirth himself suggests that such research will be inadequate unless it includes the search for knowledge on power relations among men, and the means for generating the will and the capacity for action directed toward the achievement of a good society. The social scientist is, in fact, coming to recognize the importance of investigating just those fields to which the economist is directing attention in considering the limitations of social and economic planning; while psychologists themselves, as Prof. Donald C. Marquis shows in a paper on "Psychology of Social Change", are approaching the many problems opening up in the field of communications as it bears on social therapy and the establishment of international as well as national or industrial understanding and order. The accurate measurement at frequent intervals of the status of public opinion on international questions; the study of the basis of such attitudes by examining their relation to the quantity and kind of information held by the individuals, and their relation to other attitudes, convictions and individual traits; and the study of the means of reaching and affecting people individually and in groups—all these are fields in which Prof. Marquis believes research could yield most fruitful results.

The improvement of means of communication of information is a first responsibility, and important as it may be to improve and extend what is generally known as public relations work in respect of the flow of information, both to the public, and also to the Government as regards the trend of opinion, and for research in this field, the first task is the elementary one of securing that there is no impairment of the established channels while the new techniques—classroom communication and group discussion, the use of radio, the motion picture and advertising, or what E. L. Bernays terms the engineering of consent—are being explored and developed.

These possibilities are well brought out in the series of papers issued by the American Academy of Political and Social Science (*Annals*, **248–251**), which touch, too, on those problems in the relationship of management and labour involved in the use of such bodies as the production committee or works council as means of communication. But no one who studies this symposium of papers, thinking of the avenues of sociological research which they indicate, will be led by that vista to forget the elementary duties which lie to hand for every responsible citizen. We must, indeed, improve our channels and means of communication in both directions, alike between Government and governed, manager and operative; but above all, as Prof. Williamson and the Hon. Karl E. Mundt both indicate, we must so far as is possible replace Government control, direct or indirect, over sources of information and means of communication, by the conscious and spontaneous self-control exercised by those who recognize that a great social system can only be built on rational action and on some sacrifice of personal interest to the welfare of the community.

There are old as well as new techniques which can be used to enable the community to understand the need for this sense of social responsibility. There is no greater danger to a free people than that of dictation or of neglect by the Government to dig deep the channels of assent to legislative or administrative action. The papers in these volumes from the American Academy of Political and Social Science, as well as the discussions at the Dundee meeting of the British Association, demonstrate how grave is the situation and how important it is that further research into this question of communication, its techniques and organisation, should be pressed forward from the point of view of production and national recovery. They show also that all men of goodwill should unite to resist the encroachments on the old freedom of thought and utterance which war-time practices and administrative ineptitude are still making, both in the field of science and in the world at large.

THE PREDICTION OF NATURAL FREQUENCIES OF VIBRATION

The Escalator Method in Engineering Vibration Problems

By Joseph Morris. Pp. xv + 270. (London: Chapman and Hall, Ltd., 1947.) 21s. net.

THE problem of calculating the natural frequencies of a dynamical system is of considerable technical importance in many branches of engineering and not least in that branch of engineering called instrument-making. It is important for the designer to be able to predict natural frequencies for two main reasons. First, in order to avoid the occurrence of resonance, that is, agreement of a natural frequency with that of some periodic forcing agency; this is of particular importance in rotating and reciprocating machinery, where persistent resonance in service is dangerous. Secondly, in instruments where response and stimulus should be linearly related over a band of frequencies, approach to resonance cannot be allowed, as this destroys the required characteristic. All this is true of electrical and of electro-mechanical systems as well as of purely mechanical ones.

The main purpose of the book under review is to put forward a method for calculating the natural frequencies and modes of systems having a finite number of degrees of freedom, or which can be represented as such. The special feature of the method, which is indicated by the word 'escalator', is that the solution is worked out in a succession of steps in each of which the number of degrees of freedom is one greater than for the previous step, until the full number in the system is attained. Determinants are not used, and the equations determining the frequencies and modal ratios at each stage are easily constructed from the results obtained at the previous stage.

The reviewer believes the method to be new, and the examples included in the book amply demonstrate that it is workable and useful in the hands of an expert. Whether the inventor's great enthusiasm for the method is fully justified only experience can settle. Undoubtedly the method is particularly well suited to those problems where most of the dynamical system is constant but where parts of it are subject to variation, for it may be possible so to arrange the calculations that the variable elements only appear in the last stages of the 'escalator'. When this is so, considerable saving in labour may result. It is just on the question of economy of labour for results of given accuracy that the method must be judged, as it has no advantage of elegance and, of course, it yields theoretically the same results as orthodox processes. It should be added that the special advantage just mentioned is not peculiar to the Morris escalator; it is shared to some extent, for example, by the method of partition or of sub-matrices.

The contents of the book are considerably wider than the title would indicate, for the first seven chapters are devoted to discussions of problems in the statics of beams and structures. A welcome feature is the inclusion here of a chapter on the Hardy Cross method and some of its extensions, but the author does not remark the fact that all such methods are essentially the same as the Gauss–Seidel method for the iterative solution of simultaneous linear equations. Applications of the escalator process, for the most part to problems arising in aeronautics, occupy the last eleven chapters.

Unquestionably the author has written a stimulating and useful book which embodies the results of many years of enthusiastic work, and he is to be congratulated on bringing this to fruition. The reviewer must express his regret that the author has never adopted the notation of matrices in his work on vibrations and structures, since the gain in clarity and conciseness is enormous. W. J. DUNCAN

THE FINAL INTEGRATION

The Integrative Action of the Nervous System

By Sir Charles Sherrington. With a new Foreword by the Author and a Bibliography of his Writings. Pp. xxvi+433. (Cambridge: At the University Press, 1947.) 25s. net.

IN July the seventeenth meeting of the International Physiological Congress was held in Oxford. It was the first since the meeting at Zurich in 1938, and like other post-war congresses it was a most enjoyable reunion. The organising committee had many problems to face in planning for a meeting with an attendance of 1,300; but at least it had no difficulty in choosing an appropriate gift to the members. What was needed was some classical English work on physiology; for a congress at Oxford, therefore, what better choice could have been made than a new edition of Sherrington's Silliman Lectures, "The Integrative Action of the Nervous System"? This famous book was published in 1906: it laid the foundations of the neurophysiology of the brain and spinal cord as we know it to-day, and though it has been out of print for some years it is still an essential introduction to the study of the central nervous system.

The Yale University Press, the original publishers, kindly allowed the Physiological Society to bring out a fresh edition. The preparation was entrusted to Prof. Samson Wright, and all physiologists and neurologists will be grateful for what he has done. The text is reproduced without alteration; but the blocks have been redrawn, a bibliography and a photograph of the author have been added, and, best of all, a foreword by him specially written for this edition. In it Sherrington has given us his mature judgment on the wider issues raised by his work. By isolating the spinal cord from the dominance of the brain he was able to analyse the mechanism of simple reflex behaviour. In the brainless animal we study the automatic responses of a 'Cartesian puppet', and the simple reflexes give the clue to its nervous machinery. They are, for the most part, convenient experimental abstractions; they have been most valuable in understanding the integrated behaviour of the whole organism, but clearly they are not enough. In man at least we shall never understand behaviour unless we bring in mental as well as physical events.

In "Man on His Nature", Sherrington has dealt with this cardinal problem of neurology, and in these twelve introductory pages he returns to the theme, stressing the difficulty of welding together the two incommensurables, the physical and the psychical series of events. The liaison between them is a problem still unsolved, remaining where Aristotle left it more than two thousand years ago; but Sherrington's discussion of "the last and final integration" gives it physiological as well as philosophic interest. Though the duality remains we can face it more boldly when we think of the amazingly complex adjustments which the mindless animal can carry out.. Indeed, when we consider the behaviour of a series of animals with more and more elaborate nervous systems, it would be quite impossible to say where psychical activity begins. It is present in man at all events, and the final chapter in Sherrington's book points the way to its study in terms of the physical apparatus of binocular vision.

The experiments on reflex activity described in the earlier chapters were made at a time when the graphic recording of muscular contraction was the most accurate method of following the time course of spinal excitation. Nowadays, electrical methods give a precision reckoned in tenths of milliseconds instead of tenths of seconds. The finer details of the reflex arcs have been explored and the literature of synaptic conduction would run into volumes. Yet Sherrington's work remains the framework for any detailed picture of nervous integration; what he describes as his "rather elderly volume" has lost none of its vitality. It is a work which British physiologists were proud to give to their colleagues in celebration of the Oxford congress.

E. D. Adrian

THORPE'S DICTIONARY OF APPLIED CHEMISTRY

Thorpe's Dictionary of Applied Chemistry

Fourth edition, revised and enlarged. Vol. 7: Iodazide—Metellagic Acid. With an Index by Dr. J. N. Goldsmith. Pp. xii+629. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1946.) 80*s*. net.

THE third edition of "Thorpe" originally ran into seven volumes. The fourth, in the same span, takes us only halfway through the alphabet, and if the standard were maintained (and it can be stated forthwith that it is) on simple proportion we might expect it to be twice as useful. In fact, the ratio is even higher since, with the exception of a few short items, mainly on minerals, the whole of the subject-matter has been rewritten, only the more important parts of the older material being retained and incorporated with the new matter. Merely to browse through this book is a most salutary proceeding for, apart from inducing a fuller appreciation of all the work that has been involved in the production, it brings home with a startling jolt how much there is that one does not know. It follows that, when in search of a piece of information, it is wise to "look it up in Thorpe" first. Of course, the answer is not always there; no one book or set of books could contain all the answers; but the state of the volumes of "Thorpe" after several years in a library or general laboratory is a dumb token of appreciation.

One of the fascinating features of "Thorpe" is the width of the net which it casts. No better example of this could be given than the article on 'Lichen Substances'. This is an interesting group if only because it contains the few naturally occurring organic compounds containing chlorine so far known; but also it is one which does not reach the limelight to the same extent as some other plant products such as the alkaloids or the essential oils with their more practical applications. That the subject is not overlooked by chemists is clearly indicated by the extension which has been called for in the revised article. The lactones form another group well represented in Nature, but these have spread through commercial demands for coumarin and undecalactone, to mention just two, into the realm of the chemical works. Butyrolactone comes within the range of Reppe's acetylene programme; but it is rather early for the information on this remarkable work to have penetrated beyond the special reports thereon.

As a good example of the appreciation (using the word in both senses) of values, the subject of lignin, formerly dismissed in a few lines, is now allocated more appropriate space in view of recent developments, particularly in the United States. The new article on meat extract presents a very fair picture of a subject on which there has been much divided opinion.

In accordance with the expressed policy of the new editorial board of extending the increasingly important physico-chemical subjects, topics such as magneto-chemistry, mass spectra, membrane equilibria, luminescence, mesomerism, liquid crystals, structure of liquids are dealt with at some length. No one, least of all the authors, would claim that these articles are a complete guide to the subjects, but further guidance is given by the inclusion of extensive bibliographies. Among the smaller contributions of this type may be mentioned isoelectric point, lyotropic series, Kerr constant, ionization potentials, isochore and Joule's equivalent.

The general treatment of such of the elements as fall within the literal scope of this volume follows the familiar lines of describing, as appropriate, occurrence, extraction, refining, physical and chemical properties, uses, alloys and compounds, both inorganic and organic; naturally one does not expect to find here all the minutiæ given in "Mellor".

Some disappointment was felt at the lack of detail on the nature of additives for lubricating oils; but, in fairness, it must be admitted that a plea of extenuating circumstances can justifiably be made. On one hand, the number of compounds which have been proposed for the purpose is enormous, while on the other, commercial reticence about those which are actually used is natural enough; moreover, it is doubtful whether the precise nature of some of these products is known.

It would be an invidious task to quote names of contributors; suffice it to say that they are such as to command the respect due to authority in their various fields. On the material side, the now familiar jacket of blue is maintained undimmed, but the stringency of the paper position is reflected in an irregular alternation of colour coupled with quality. The paper is adequate, but it is to be hoped that supplies of at least a uniform tint will be available for subsequent volumes. However, better a "Thorpe" in cream and white rather than no "Thorpe" at all.

B. A. Ellis

SOCIAL IMPROVEMENT BY EDUCATION

Some Tasks for Education

By Sir Richard Livingstone. Pp. vii+98. (London, New York and Toronto: Oxford University Press, 1946.) *5s.* net.

THE four lectures in this volume were delivered in September 1945 at the University of Toronto—the first three on the Burwash Foundation and the fourth as the Sir Robert Falconer Memorial Lecture. Although they are not consecutive, all deal with aspects of a single problem—how to improve ourselves and our society by education—and are a valuable corrective to the current obsession of educationists for dealing with means rather than ends. Those who are familiar with Sir Richard's earlier writings will not be surprised to find that, although he examines proposed revisions of curricula to meet the needs of the modern world, he is chiefly concerned to emphasize, as the prior task of education, the need "to inspire and to give a sense of values and the power to distinguish what is first-rate . . . from what is not". "It is", he declares, "right to teach the pupil to criticize, but it is even more important to train him concurrently to admire." To him "nothing—not all the knowledge in the world—educates like the vision of greatness, and nothing can take its place".

The most challenging passages in these lectures are concerned with the training of character. While the creation of the first-rate in art, literature, thought and science must still be—as it has been in the past—the prerogative of the few, Sir Richard has no doubt about the ability of every human being to create the first-rate in the field of character. His indictment of modern education is its failure to afford this opportunity to every individual. Is it, as he suggests, really true "that in most modern educational schemes the training of character, if not neglected, has been given a subordinate place; that we have very little, if anything, like the concentration on it in Plato's thought and in Arnold's practice?" It may well be that the only way to learn social habits is "by living a life in which such habits automatically develop", but does it necessarily follow that the training of character is difficult, if not impossible, outside the British boarding school?

Educationists who have to struggle with conditions far inferior to those found in the public schools may justifiably be irritated by Sir Richard's preoccupation with Plato, boarding schools and Periclean democracy. Nevertheless, if he is right that the British boarding school has been the finest factory of citizenship in existence, few will be able to gainsay his conclusion that "we should give to the many some equivalent of the training we have given to the few".

MATHEMATICAL STATISTICS

Introduction to Mathematical Statistics

By Assoc. Prof. Paul G. Hoel. Pp. x + 258. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 3.50 dollars.

ONE consequence of the 'export drive' in Britain is likely to be a much increased demand for the mathematical statistician in industry; unfortunately the supply of suitable people is still far too small, and this must largely be attributed to the shortage of teachers and the absence of suitable text-books. Hoel's "Introduction to Mathematical Statistics" seems to me to be an excellent work, and if only it can become generally available it may have a most favourable effect on the situation just described. In spite of the restrictive effect of the present licensing system, means should be found of introducing the book widely in Britain. Placed in the hands of any intelligent mathematical undergraduate, it will give him in a few weeks not only familiarity with the broad outlines of the subject but also a real understanding of the types of problem with which the research worker in this field is contending.

The first six chapters cover the usual introductory material, in a manner at once accurate and attractive. There follow brief accounts of a variety of more advanced topics: multiple regression, multiple and partial correlation coefficients, discriminant functions, small-sampling distributions (t, χ^2, F, the range, etc.), non-parametric methods (the theory of runs, the Wald–Wolfowitz treatment of serial correlation), χ^2 and tests of goodness of fit, the Neyman–Pearson theory of statistical tests, and the design of experiments (including notes on stratified sampling and sequential analysis). Up-to-date references, exercises both realistic and interesting, the usual tables (together with a very useful one of squares and square-roots) and a satisfactory index complete the work. Of course it is easy to ask for more; one would have liked to see some mention of cumulants, of the characteristic function, of Fisher's exact test for 2 × 2 tables, and a more adequate account of maximum likelihood estimation. But the author was probably wise in not overloading the book; it will leave many readers full of a most healthy curiosity.

David G. Kendall

Tables de constantes et données numériques

1: Constantes sélectionées, Longueurs d'onde des émissions X et des discontinuités d'absorption X. Par Y. Cauchois et H. Hulubei. Pp. 200. (Paris: Hermann et Cie., 1947.)

SINCE the publication of Siegbahn's "Spektroskopie der Röntgenstrahlen" no authoritative list of wave-lengths of X-ray emission lines and absorption edges has been published. Cauchois and Hulubei have performed a praiseworthy task in presenting these data in one volume; they give the wave-lengths in order of increasing magnitude, values of ν/R and $\sqrt{\nu/R}$, and references to original sources. An additional table gives the values for non-diagram lines (which are probably due to transitions in multiply ionized atoms), and an appendix gives the data for each element arranged in order of atomic number.

It will be seen that the book is of interest mainly to X-ray spectroscopists, and for their convenience simple multiples of the wave-lengths are also inserted in the main table. These are described as higher orders, which means that they are the wave-lengths that would be deduced if the observed lines were taken as first-order diffractions.

The authors have chosen the results of particular researches for inclusion in their tables, rather than the means of recent determinations. It is difficult to see the justification for this, when many workers have produced results of comparable accuracy. Some discussion of the whole question of accuracy would have been valuable, since X-ray crystallographers have tended to accept data given to any number of figures. It is pleasing to note that the authors have not given any *real* values (that is, first orders in their notation) to more than six figures, so that, for example, CuKα appears as 1537·40 X. instead of the usual 1537·395 X.; but one would have welcomed more discussion of this question of accuracy.

H. LIPSON

Experimental Embryology in the Netherlands, 1940–1945

By Prof. M. W. Woerdeman and Prof. Chr. P. Raven. (Monographs on the Progress of Research in Holland during the War.) Pp. xi + 132. (New York and Amsterdam: Elsevier Publishing Co., Inc., 1946.) 6.50 fl.

THIS small volume was prepared by Profs. Woerdeman and Raven during the last months of the War, with the purpose of presenting as soon as possible an account of the work which had been done in experimental embryology during the German occupation, and which had therefore remained either unpublished or at least unknown to men of science of the Allied nations. When one considers the difficulties under which the work must have been done, the record is a remarkable one. The group at Utrecht under Raven has made an intensive study of the egg of *Limnea*, a representative of the so-called 'mosaic' eggs which have been rather unfashionable experimental material in recent years. Their careful histochemical study of the process of maturation, and their description of the different plasms and their behaviour after centrifugation, may be expected to direct the attention of students of general cell physiology to the extraordinary but fascinating phenomena to be seen in the cytoplasm of egg-cells. In Woerdeman's laboratory, work has been mainly on the more classical object of the Urodele egg. Perhaps the most striking new line of attack is that opened by experiments of ten Cate in which he has shifted the time of embryonic determination relative to that of anatomical development.

Elsevier's Encyclopædia of Organic Chemistry

Edited by E. Josephy and F. Radt. Vol. 14: Tetracyclic and Higher-Cyclic Compounds, Series 3: Carboisocyclic Condensed Compounds. Pp. xx + 711. (New York and Amsterdam: Elsevier Publishing Co., Inc., 1940.) n.p.

IT is impossible to give a critical review of what, after all, is a dictionary or catalogue.

The volume at present under consideration covers all condensed-ring hydrocarbons, sterols, bile acids, sex hormones, heart poisons and sapogenins. It is claimed that the literature is covered up to the end of 1936; but in fact the book also contains many later references, going as far as 1939. We are informed that periodical supplements are to be published, and these will doubtless bring the references up to date.

The related compounds are also found in tabular summaries or charts showing their interrelationship and methods of formation. There is an excellent formula index, as well as a very complete subject index containing even such compounds as desoxytetrahydroanhydrodigitoxigenin.

From the production point of view the volume is excellent; the formulæ are very clearly drawn and the text is easy to read.

The book should be of great assistance to sterol chemists, especially those who have no access to a modern edition of Beilstein. It is a convenient source of reference to a large number of organic compounds, thus saving much time spent in searching through Beilstein and numerous abstract indexes.

The present volume is No. 14, and the price of this is quoted as in the region of 60 dollars. Subscription to this series is therefore no light matter.

Functions of a Complex Variable

By Prof. Thomas M. Macrobert. Third edition. Pp. xv + 390. (London: Macmillan and Co., Ltd., 1947.) 18*s*. net.

IT will be recalled that this volume first made its appearance in 1917. After a reprint in 1925, a second edition followed eight years later, and this was also reprinted in due course. It contained a considerable amount of additional subject-matter, occupying some fifty pages, mainly devoted to the study of special functions, and it is interesting to note that a reviewer at the time described it as a book in which the student would find just the material he required, clearly set out and with sufficient rigour for his needs, without delving too deeply into abstract theory.

No greater justification of this statement and no more convincing proof of the usefulness of the book to students of the theory of functions could be provided than the fact that the production of yet another (the third) edition has taken place in such a short space of time. On this occasion the author has again extended the scope of the work by a further twenty pages, constituting an appendix on generalized hypergeometric functions, together with another set of miscellaneous examples. Apart from these additions, the contents are identical with those of the second edition. In spite of present-day austerity, the book is well bound and clearly printed, and it seems natural to suppose that it will continue to enjoy a well-earned popularity.

J. H. PEARCE

FUNDAMENTAL PHYSICAL THEORY

CONFERENCE AT BIRMINGHAM

PROGRESS in physical theory has from time to time come to a standstill during periods in which the theory has become increasingly complex and incapable of accounting for the observed phenomena, and which have eventually been resolved by the emergence of a fundamentally new idea. Examples of such new ideas are the electromagnetic theory of light, the older quantum theory, the principle of relativity and the new quantum mechanics. The present is again a time of failure of physical theory. The impasse has lasted about ten years, but the required new idea is still lacking. It was against this background that an informal conference on fundamental physical theory was held in Birmingham during the period July 23–26. About eighty people attended, of whom some thirty came from outside Great Britain.

The discussion at the first session was opened by Prof. R. E. Peierls, who gave a review of the difficulties associated with infinite self-energies and of the attempts that have been made to overcome them. This topic occupied the conference for the first two half-day sessions, and was resumed at the final session on July 26, which had been left free from agenda. Already in classical electrodynamics infinite self-energies occur if it is assumed that electrons and protons are point charges; but with the development of quantum theory it had been hoped that they would disappear, as had other difficulties of classical physics. Such hope has proved unfounded, and, in fact, quantum electrodynamics introduces new infinities connected with fluctuations of the electromagnetic field.

Recent attempts at removing these difficulties, none of which has proved satisfactory, fall into two classes: those which try to give a consistent formalism leading to finite results without introducing a fundamental length into the basic field equations, and those that do.

Foremost in the first class is the theory of Dirac involving the so-called λ-limiting process and introducing an extra field of redundant variables. Dirac succeeds in putting into Hamiltonian form equations which in the limit give the equations of electrodynamics, free from infinite terms. The equations can be translated into quantal terms in the usual way, and when supplemented by the redundant variables, which in a formal way correspond to negative-energy photons, give rise to no divergent integrals when solutions are sought by the usual perturbation methods. The detailed physical interpretation of the formalism is not unique, but to the simpler problems it gives unambiguous answers in agreement with observation. A feature of the equations of motion of point charges is that they possess 'runaway solutions' in which the particle accelerates asymptotically towards the velocity of light. They do not correspond to real motions and can be eliminated, at least in the classical version of the theory, by postulating extra boundary conditions of an unusual type (final, as opposed to initial, conditions); but in the quantal theory this cannot be done so simply, and a difficulty appears to persist.

Along rather similar lines is the application by Gustafson and Fremberg of an analytic method of dealing with hyperbolic differential equations developed by M. Riesz. In classical theory it leads to the same results as the λ-limiting process. The application to quantum theory is claimed to give useful results; but several objections were raised in the discussion to Gustafson's arguments.

The difficulties with infinities appear to be characteristic of field theories. Attempts to avoid the field concept and revert to an action-at-a-distance description are therefore attractive. One such theory of interest has recently been proposed by Wheeler and Feynman. It involves the propagation of influences backwards, as well as forwards, in time; but with the help of a plausible assumption, namely, that all radiation emitted will eventually be reabsorbed somewhere in the universe, it can be shown to be equivalent to the field description. Although no complete quantal version of the theory exists, it was felt by several members of the conference that it would meet with essentially the same difficulties as field theory, and objections (albeit inconclusive) were raised against it on the grounds of conflict with the quantal theory of observation.

Another attempt at avoiding infinities, due to Heitler, is the so-called radiation damping theory which prescribes rules for ignoring infinite terms arising in the calculation of radiative processes by perturbation methods. Arguments were put forward during the discussion to show that the neglect of these terms in the calculation of the energy implies neglecting terms which are essential in obtaining correct answers to other problems, notably the emission of soft radiation in *Bremsstrahlung*, as pointed out by Bethe and Oppenheimer, and the propagation of light with finite velocity. A precise formulation of the rules is, in any event, lacking; they imply a division of photons into 'real' photons, and 'virtual' photons associated with the near field of a charge, a division which cannot be made unambiguously within the framework of the present theory.

It is theoretically possible to construct a field theory in which the self-energy of a singularity is negatively infinite. If it is assumed that in addition to the electromagnetic field such fields are set up by charged particles, and that they fall off very rapidly with distance so as to be negligible at atomic distances, it is possible to construct a theory which reproduces the observed forces between particles on the atomic scale, and which by suitably choosing the coupling constant of the new field cancels out the positive with the negative infinity. Such theories have been studied by Bopp, Stueckelberg, and more recently and in greater detail by Pais. Proceeding by perturbation methods, Pais has shown that the infinities in the terms up to second order can be eliminated; but it is not clear whether this holds for higher orders.

Various attempts at interpreting the results of the equations as they stand were discussed at the conference, such as by calculating finite differences between the energies corresponding to different states and similar methods. Peng has, in fact, recently claimed to show that the infinities arise from the approximation methods and are not inherent in the theory; but there are flaws in Peng's argument and his contention has been abandoned. The underlying idea of the finite difference method is the convergence of a series (or integral) formed by the difference of two series which themselves diverge; if there is a unique correspondence between terms, such a sum may be expected to have a physical meaning; but in most cases the correspondence is ambiguous and often even the difference is divergent. Particular interest attached to a letter from H. A. Bethe who had in this way calculated a correction to the fine-structure separation of the hydrogen levels in the direction indicated by the microwave observations of Lamb and Retherford.

An early theory of the fundamental length type is the non-linear electromagnetic theory of Born and Infeld. Its practical consequences are so difficult to calculate that it is not possible to say that it has been disproved, although one would prefer a simpler description of phenomena. Another approach is to introduce a 'structure factor' for electrical particles, which can be done without conflicting with the principle of relativity only by assuming that the charge density at a given time depends on the position of the particles at other times. Such a theory can be made to avoid the classical infinities and probably the run-away solutions, but no quantization has yet proved feasible.

A more fundamental change of view is contemplated in a series of papers by Snyder, who considers a 'quantized' space-time. In his theory the space and time co-ordinates are non-commuting quantities, the eigen-values of the space co-ordinates being discrete (the interval between them thereby introducing a fundamental length). The idea still needs further development; but is indicative of the radical departure from our present ideas which may be necessary.

One session was devoted to mesons. There are so many variants of the theory that it is difficult to speak of agreement with experiment, but in general it seems to be poor for scattering and *Bremsstrahlung* processes. The agreement is insufficient to indicate the value of the meson spin. That negative mesons stopped in carbon and other light elements have time to decay into electrons before being captured by carbon nuclei is an experimental result which challenges the theory. According to calculations of Fermi, Teller and Weisskopf, it is in conflict with the meson theory of nuclear forces; Bohr, on the other hand, has criticized their argument and suggests that there is no disagreement. Dr. Ferretti reported on more comprehensive calculations, which show how complicated the process of the stopping of mesons really is, and which, while very provisional, do indicate a conflict with experiment, though smaller than calculated by Fermi *et al.*

Our knowledge of mesons is still so incomplete that we do not know how many different kinds exist, nor with certainty from what particles they can be formed and into which particles they disintegrate. A report on the recent observations by the Bristol group, of mesons 'disintegrating' into other mesons, probably with the emission of another unidentified particle, and of mesons causing nuclear disruptions, was of interest in this connexion.

Two sessions were devoted to nuclear theory, including the meson theory of nuclear forces. Consequences of this theory can only be calculated quantitatively for the simplest nuclei, and agreement with experiment is poor in view of the number of variants. The theory suffers from the infinities of all field theories, which here lead to greater difficulties than in electrodynamics. There were reports on calculations of magnetic moments, photo-disintegration of the deuteron, scattering of protons and neutrons and the effect of 'tensor forces', which, generally speaking, gave vague support for certain specializations of the theory. It was clear that the time is not yet ripe for detailed calculations on complex nuclei, although one may profitably study such problems as the possible rotations of heavy nuclei, which involve only general considerations, and the regularities of nuclear spins, which are zero for all nuclei containing an even number of protons and of neutrons.

The conference was throughout kept on an informal level and owed much of its success to the organisation undertaken by members of the theoretical physics department of the University of Birmingham, and to the hospitality of the University, which not only gave financial aid, allowing distinguished physicists from abroad to be invited, but also entertained to dinner all members of the conference on the evening of July 25. The conference provided an ideal opportunity for the interchange of ideas, such as is often absent from a more formal conference, even though it made abundantly clear that the fundamental idea essential to further progress in physical theory is still lacking.

M. H. L. PRYCE

THE WORLD FEDERATION OF SCIENTIFIC WORKERS

By J. G. CROWTHER

THE World Federation of Scientific Workers was founded in July 1946. It is a natural outcome of the growth of science, and of the scientific profession, in many countries. Associations of scientific workers concerned with the problems of scientists as scientists in general, rather than specialists in a particular technique, began with the foundation of the National Union of Scientific Workers in the United Kingdom in 1918. This body was originally a trade union; but, it relinquished this status for about two decades, resuming it in 1941. Its name is now the Association of Scientific Workers, and it has more than eighteen thousand members. The success of the Association, with its young and widely varied membership, has made a deep impression in many countries overseas. Consequently, when the Association took the initiative in proposing a world federation of similar bodies, it found an enthusiastic response.

The World Federation of Scientific Workers already contains seventeen affiliated bodies in fourteen countries from all five continents. It is able to call on a very wide range of experience for advice.

The fundamental aim of the Federation is to strengthen the mutual aid and information between scientists in every country, so that the strength of the scientists in one country shall be the strength of all their colleagues throughout the world. It is hoped to further through the Federation the achievement of agreed opinions on those questions which affect all scientists alike, irrespective of their speciality. In this way the scientists of the world will be able to speak with one voice on matters that affect them fundamentally. Towards this end the Federation is preparing a Scientists' Charter, defining the duties and rights of scientists, which should be observed in all countries. In every place, it will be possible to compare the actual situation with that given by the Charter, and thus assist scientists everywhere with a guide to a proper status for science and scientists. The standards of education, remuneration, working conditions, opportunities for work, and the control and direction of science vary greatly over the surface of the globe. Scientists have special knowledge of science, and in virtue of this they have the responsibility of seeing that the public is correctly informed on scientific matters which affect public affairs.

The World Federation seeks to keep in touch, and collaborate, with other international bodies concerned with science, such as the United Nations Educational, Scientific and Cultural Organisation, and the World Federation of Trade Unions. U.N.E.S.C.O. has already invited the Federation to send an observer to one of its panels, and it has invited the Federation to send an observer, subject to confirmation by the Conference itself, to the present U.N.E.S.C.O. Conference at Mexico City.

Another direction in which the World Federation has been able to contribute towards international understanding between scientists is in collaboration with other scientific bodies in the commemoration of scientific personalities and events of international significance. It joined with the Association of Scientific Workers and the Society for Visiting Scientists to organise meetings in memory of Paul Langevin, and it has joined with the Association des Travailleurs Scientifiques and the Syndicat National de l'Enseignement Supérieur et de la Recherche Scientifique in organising, under the patronage of the President of the French Republic and the Académie des Sciences, a meeting in Paris in commemoration of the tenth anniversary of the death of Lord Rutherford. The occasion will be an opportunity for remembering the great physicist, and reflecting on what has come of his work, and that of his colleagues in physics. A special feature of these meetings is that they have been organised primarily by the scientists of one country in celebration of the achievements of a scientist of another country, and have thus contributed towards the strengthening and understanding of mutual dependence and sympathy in science.

The president of the World Federation of Scientific Workers is Prof. F. Joliot-Curie, and its registered headquarters are in Paris. French-speaking inquirers can most readily receive further information about the Federation from the Secrétaire Général, 47 Boulevard St. Michel, Paris V, and English-speaking inquirers from the Secretary-General, 15 Half Moon Street, London, W.1.

THE PAINT RESEARCH ASSOCIATION

By Dr. L. A. JORDAN

Director

THE co-operative industrial research association movement in Britain is an interesting development, whatever may have been said or written about it, particularly during the last few years. Those responsible for controlling the work of the associations and of holding together on a voluntary basis a heterogeneous membership with varied views as to what co-operative industrial research is about, are conscious of the limitations and have no illusions about the weaknesses of the system. They have the responsibility of watching the interests equally of all their members; no duty could be more difficult, and errors of judgment are not lightly tolerated. Displeasure, however transient, saps enthusiasm, without which nothing is achieved; on the other hand, confidence is a plant of slow growth, but it is essential and it can be won.

One must admit that the crux of the matter, or at least one aspect of it, is the interpretation placed by individuals on the word 'co-operative' and how it is related to the primary and universal human instinct of self-interest—which may come to be regarded as self-preservation. Research work is not the only human activity in which it must be recognized that there are degrees in co-operation, and that it does not do to strain even the best of good intentions. Fortunately for research association work, many industries have a wide background of technology waiting for first-class scientific investigation from which information may be gained acceptable to all, provided it is brought only to a certain stage. That stage is when each member firm according to inclination and capacity can take the material information offered and develop it within the ambit of the firm's interest.

Inevitably that stage is too far for some—or at least they think so; definitely not far enough for others, and certainly not far enough to ensure a widespread, rapid and effective absorption of research results into the technical administration of the industry. How to deal with that problem may give rise to differing opinions and to much honest doubt. The uneasiness so frequently expressed about the research association movement is justified in so far as it is prompted by concern as to whether means can be found to give a better overall performance, meaning the integration of the results of scientific work plus development plus utilization by the greater part of an industry.

In the meantime, while such problems are being resolved, directors of research associations have to operate the instrument provided and, coming down to a homely metaphor, the 'proof of the pudding' test still holds. If one is so minded, many quite logical and apparently sound reasons can be found why the research association idea should not work out in practice; but, in fact, the associations have not done too badly. As with most human enterprises, everything turns upon the degree of satisfaction accorded to the participants, not the least important, particularly in time of war, being the State. It is true to say that had the research associations not existed in 1939, Britain would have lacked a very powerful weapon; for the associations made it possible to mobilize at short notice in industry by industry most of the scientific and technical knowledge available, and they provided facilities for the immediate investigation of new problems under most favourable conditions.

In a number of cases, particularly those concerned with the traditional industries, associations were not easy to start; thus it was not until 1926, that is, ten years after the movement began with the establishment of the Department of Scientific and Industrial Research, that the Paint Research Association was formed. The term 'paint' in this context includes colour (that is, pigments), varnish, printing ink, certain aspects of linoleum—in fact, all those procedures which depend upon a related technology of incorporating a solid into a fluid medium.

It is pertinent to ask what the Association has done during its twenty-one years and what it proposes to do—two questions which can be taken together in so far as they can be dealt with adequately in this short statement. First, there has been too great a tendency to judge research associations by the flashing discovery that solves all problems. That sort of thing is good publicity while it lasts, but is erratic in its incidence; and industries vary in the opportunities they provide for that type of work. Even so, the impression left on the collective business mind is not likely to be as lasting as the proud inventor thinks is justified.

The real need is to make and hold satisfied customers who tell their friends, and that means good nourishing fare, regularly supplied; if some special treat can be provided occasionally, so much the better. The rhythm of the Paint Research Association has been steady rather than spectacular. Much diffused information on many subjects has been brought together and records annotated, interpreted, presented and used with satisfaction. A goodly portion of the scientific background of the industry has been filled in effectively, and thereby some relief has been given to the pains of scientific indigestion, arising from the flood of new chemical substances which find uses as bases for paint materials. The volume of investigational work incidental to the provision of substitutes (to use the current phrase), better described as the proper utilization of available materials, particularly during and since the War, has been very large indeed; and some useful items have been discovered in the process. The resources of the Association have been spent, for the most part, in carrying out scientific work in the laboratory on subjects (of which an indication will be given later) arising out of problems, both short-term and long-term, peculiar to the industry.

Many factors have operated everywhere during the last generation to affect the outlook of the paint and related industries; the British industries have been greatly altered as a result of research association activity. No claim is made about monetary savings arising out of the adoption of some specific process, because we have not operated that way; yet it must not be assumed that members of the Association have not benefited financially. Indeed, not a few manufacturers admit to new and profitable procedures having been developed by them as a result of direct advice from the staff, or by utilizing hints and recommendations in technical papers.

Two years ago, a survey of the problems of the paint and allied industries was made which presented a conspectus of the field of interest, with a shorter list of collateral studies in related fields entitled "Investigations at Present Envisaged", on the basis of which work is proceeding as circumstances permit. At the same time, appropriate reference was made to matters which had already occupied the attention of the research staff to such an extent as to have resulted in a technical paper or other publication on the subject. The number of such references is impressive.

It is usual to think of paint in terms of its colour, and that means the pigment which often gives the name to the paint. A solid powder in a liquid does not necessarily make paint, and it is reasonable to accept the view that much of scientific and technical interest is to be found in the conditions operating at the interface between the pigment and medium constituting a paint—such as the wetting and dispersion of pigments, properties which must be evaluated and assessed, or the manner in which the rheological properties and other characteristics of paints are influenced by pigment/medium volume relationships and by physical factors, that is, actual physical form and surface condition, the volume and packing characteristics and the state of flocculation of the pigment. These things, among others, determine the nature of the liquid paint, its behaviour on storage (settlement, skinning, etc.), its behaviour in use (brushing quality, opacity, spreading power, etc.), its film properties (gloss, colour, hardness, resistance and sensitivity to water attack, permeability, rust inhibition, etc.) and durability which in the first instance largely depends upon adhesion to the support. All this is not due alone to interfacial conditions; but they are very important.

The different methods of application of paint and varnish and the nature and preparation of the surface of the material painted (metals, plaster, various woods, and now plastics), the manner and mechanism of film formation, the physical relationships between coats in multiple-coat films and the significance of such matters as threshold film thickness, pigment particle and molecular orientation, are all important aspects of study, as is evidenced by the large number of technical papers and research memoranda issued, approximately 150 of each. A few of these papers, dealing with "Priming of Joinery Timber", "Painting of Plaster" (from the Building Research Station), "Painting of Non-ferrous Metals", "Preservation of Iron and Steel by means of Paint", have been available to the general public. Perhaps the most notable contribution of the Paint Research Association to public papers is the book entitled "Painting of Buildings", No. 5 in the Post-War Building Series (H.M. Stationery Office); also an important contribution has been made to the Building Research Station reports on the repair of damaged buildings.

In addition to the rather general observations made above about work relating to paints and paint application, there are seven other sections into which the technology of the related industries is divided for convenience in presentation; namely, oils, varnishes and resins, pigments and chemical colours, cellulose and other lacquers, testing, bitumens, blacks and pitches, and anti-corrosion.

Oil to the paint industry, of course, means the natural drying oils and mainly linseed oil, which is still, as it has long been, the backbone of the industry. At the present time there is a good deal of publicity being given to the problem of 'substitute linseed oil', which is not an easy problem on the large scale. During the War, great efforts were made to produce, by treatment and manipulation of other oils—castor oil in particular—a product simulating the properties of tung oil; circumstances have now changed and the urge to-day is to simulate the properties of linseed oil by treatment of one or other of the semi-drying oils. The indications are that selective solvents will permit the segregation at reasonable cost of soya bean oil, rubber seed oil or candlenut oil, and possibly others, into two fractions, one rather lower and the other correspondingly higher in iodine value, which is one of the criteria of a drying oil.

In the whole range of the drying oils, including, in addition to the types already mentioned, oiticica and various fish oils, everything depends upon treatment, mainly heat with or without air oxidation. At the far end of the treatment scale, linseed oil becomes linoxyn, the gel which is the primary linoleum base.

There are, of course, partial alternatives to drying oils, namely, materials of petroleum origin and also wool-grease; the contribution of the Paint Research Association in these fields is everywhere acknowledged.

It is most necessary in an article of this kind to avoid the appearance of a catalogue, but there are still several sections of work to which no detailed reference has been made. Nevertheless, maybe sufficient has been said to indicate that the science involved in the study of paint is profound, and that the Paint Research Association is giving it attention.

ADVANCES IN PREVENTIVE MEDICINE DURING THE WAR OF 1939–45*

By Sir ARTHUR MacNALTY, K.C.B.

DURING war-time, the risks to health are many and varied; yet the essential health services of Great Britain were maintained during the Second World War at a high level of efficiency.

Vital Statistics. The estimated mean population of persons of all ages in England and Wales was 41,246,000 in 1939 and 37,785,000 in 1944. There was an addition of half a million older persons during five years of war. The birth-rate, rising from 1941 onwards, reached 17·7 per thousand in 1944, the highest it has been since 1926, and the effective reproduction-rate came within one per cent of a full replacement standard. The death-rates have not notably increased. The maternal mortality-rate fell gradually from 3·10 per thousand total births in 1939 to the low figure of 1·92 in 1944. Through sulphonamide treatment there was a notable decline in deaths from puerperal fever and sepsis. The infant mortality-rate rose a little up to 1941, but thereafter declined, and in 1944 the rate dropped to the record figure of 45 per thousand. An outstanding feature was the low mortality of children from disease during the war years.

Infectious Diseases

Generally, the chief diseases which engaged attention during the War of 1914–18 were watched for and prevented by the same means in the Second World War. These means were the maintenance of the normal health services so far as possible; port sanitary control, which guarded against the introduction of infectious diseases from abroad; purity of the water supplies; notification of infectious diseases; hospital isolation; maintenance of adequate nutrition, etc.

Smallpox. In the six years, 1939–44, 28 cases occurred in England and Wales with three deaths, all in 1944. In Scotland there were three noteworthy outbreaks in 1942, affecting Glasgow, Edinburgh and Fifeshire. Infection of a severe type appears to have been imported from the East on a ship which arrived on May 29 at the Port of Glasgow. In all, there were 72 cases with 16 deaths. The outbreaks were speedily controlled through vaccination of patients and contacts, hospital isolation and disinfection.

Scarlet Fever. The incidence declined in the period 1939–42; it then increased to epidemic proportions in 1943, with some regression in 1944. The low fatality-rate fell still lower.

Measles and Whooping Cough. As a measure of war precaution, notification of measles and of whooping cough became compulsory in England and Wales in 1940. Measles was severely epidemic in England and Wales in 1940 and 1941; a remission in 1942 was followed by a recrudescence in 1944, when the recorded prevalence was 158,479. The deaths in the epidemic years 1940 and 1941 were only 75 per cent of the average number in the quinquennium 1935–39, and the mortality-rate in the war years was unusually low. The recorded figures for whooping cough since 1940 indicate that the incidence of the disease is on the average much less than measles. The death-rates were not unduly high. Serum therapy gives inconclusive results, and vaccine prophylaxis, at present, seems of little avail.

Diphtheria. A striking success was achieved in the prevention of diphtheria, "the killing disease of childhood". Immunization has been encouraged by the Ministry of Health and progressive local authorities for the past fifteen years. In 1914 the campaign for mass immunization was intensified, the Ministry undertaking the free provision of prophylactics. It was roughly estimated that between 55 and 60 per cent of the child population of England and Wales had been immunized. There was a notable decline alike in the incidence and mortality of diphtheria during the war years. In 1940, when systematic immunization began, there were 46,281 notified cases with 2,480 deaths; in 1944 there were 29,949 cases with 934 deaths. Diphtheria is a preventible disease, and steady continuous effort is needed to raise the general percentage of immunized children to at least 75.

Typhus Fever. From times immemorial, typhus fever has been favoured by war conditions. For this reason, the Medical Department of the Ministry of Health took special precautions against the risk of introduction of the disease into Great Britain. The Ministry also issued a memorandum on louse-borne typhus fever, and supplies of anti-typhus vaccines were provided.

During the War, medical research has greatly advanced the knowledge of typhus, its prevention and treatment. The principal method of checking an epidemic is effective delousing of the population at risk. "No lice, no typhus" remains the guiding rule. As is now well known, the new synthetic compound D.D.T. has a toxic effect on lice, mosquitoes and flies. By its use a serious typhus epidemic among the Italian population in Naples and southern Italy was speedily checked. Delousing and vaccine therapy can now speedily control an outbreak. The conquest of this dire disease is one of the outstanding triumphs of the war period.

Cerebro-Spinal Fever. That war favours epidemics of cerebro-spinal fever is due to overcrowding and lack of adequate ventilation in camps and billets, which assist droplet infection, and by movements of troops, which lead to the introduction of fresh and virulent strains of the meningococcus. From the end of 1914 until 1918, cerebro-spinal meningitis was epidemic on an unprecedented scale in Great Britain, the case mortality-rate averaging 72 per cent. In 1938 I directed attention to the maintained incidence of notifications of the disease and the increased number of Group I meningococcal infections. For these reasons I considered it probable that another period of epidemic prevalence was approaching, a forecast unhappily fulfilled. In 1940 the disease began rapidly to increase and continued to do so into 1941. The total of notifications in 1940 was nearly fourfold that of our previous worst experience in the year 1915. During 1942, 1943 and 1944, the incidence and case-mortality gradually declined. In character the disease displayed its usual severity, and in distribution it prevailed widely. Fortunately, the use of the sulphonamide drugs, and later that of penicillin, in treatment achieved the lowest fatality-rate on record; in some outbreaks the low figure of 4–8 per cent was attained. The annual fatality-rates for the period 1941–44 were, in succession, 19·5, 20·0, 23·6 and 25·6, rates which imply a saving of approximately 15,000 lives. Chemotherapy has provided a powerful weapon against this deadly disease.

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* Substance of a Chadwick Lecture given at the Town Hall, Cheltenham, on May 22, 1947.

Malaria. Based on the work and experience of the First World War, at the outbreak of war in 1939, when the risks of malarial infection from overseas again became imminent, the Ministry of Health had an efficient organisation to hand and an expert staff conversant with the problems that were likely to arise. That these precautions achieved their aim is evident from the insignificant number of cases that occurred. This anti-malarial work has been another triumph of preventive medicine. The outlook for the conquest of malaria is promising. There are new and potent drugs ('Mepacrine' and 'Paludrine') for the prophylaxis and treatment of the disease; the employment of suppressive 'Mepacrine' in highly malarious regions has been effective in maintaining British forces in these areas in a fit condition to fight and defeat the enemy. The infective agent, the *Anopheles* mosquito, can be repelled by D.D.T., which destroys both mosquitoes and larvæ.

Acute Infective Jaundice. Acute infective hepatitis, a virus disease, has caused small outbreaks in Great Britain and extensive outbreaks among the armed forces and civilian populations in Europe and North Africa. The Medical Research Council, at the instance of the Ministry of Health and the Army Council, appointed a Jaundice Committee to investigate the disease; and to facilitate the Committee's work the Minister of Health made 'jaundice' compulsorily notifiable in East Anglia.

Scabies. Scabies had a high and rising incidence in Britain from 1930 onwards. This increase was heightened when war began, first by evacuation and mobilization, and later by overcrowding, industrial shifting of population and shortage of soap, towels, underclothing and bedding, leading to a severe and widespread epidemic of scabies. In 1941 a Scabies Order was made under the Defence Regulations which gave local authorities additional powers to deal with scabies and other verminous conditions. An advisory committee was set up by the Ministry of Health. Many local authorities took vigorous action, established scabies clinics and in some areas, for example, London, the disease was made notifiable. Special investigations were made, as the result of which benzyl benzoate has proved to be the most efficacious application.

Tuberculosis

In the First World War, there was a general rise in tuberculosis throughout Britain. The increase was mainly caused by contact infection, overcrowding and breaking down of bodily resistance to infection by prolonged physical or mental strain. These are difficult things to prevent in war-time. In 1939 the deaths from tuberculosis were 25,623; in 1941 they had risen to 28,670. The figures for the two complete war years do not include soldiers, but there was evidence for a certain increase of the disease among the Fighting Services. The figures of deaths for 1942, 1943 and 1944 showed a decline, being 25,549, 25,649 and 24,163 respectively. The most disquieting feature was that deaths among children from pulmonary tuberculosis and tuberculous meningitis increased substantially during the War. The appreciable general decline has so far been maintained, but the effects in so chronic a disease may appear later. A proportion of the deaths in the non-respiratory form are due to persons drinking infected milk.

At the outbreak of war there was a temporary dislocation of the tuberculosis services in some areas, but excellent work was afterwards done in spite of many difficulties. Evacuation, air-raids, shortage of medical officers, health visitors, nurses and of bed accommodation have all affected the normal service. The scale of rationing was regarded as adequate for the tuberculous if carefully planned as in sanatoria and hospitals. At the invitation of the Minister of Health, a representative advisory committee for tuberculosis was set up, and the Ministry gave special attention to the question of after-care. The Medical Research Council established a committee of investigation, which issued a useful report in 1942.

Recent work on chemotherapy, especially that relating to streptomycin and promin, encourages the hope that eventually a drug will be found which will destroy the tubercle bacillus in man. Miniature or indirect radiography is an important aid to early diagnosis.

Venereal Diseases

War circumstances, as is well known, favour the spread of venereal diseases, and the Second World War was no exception to this rule. The increase was most marked in females. The Ministry of Health encouraged the expansion of diagnostic and treatment facilities, and made a grant to local authorities of 75 per cent of the additional cost. Regulation 33B enabled a medical officer of health, on certain conditions, to arrange for compulsory treatment. Great advances were made during the War in the treatment of venereal diseases. Penicillin has reduced the time required for the treatment of gonorrhœa to a few days, and that for syphilis from a year to approximately ten weeks, though in both these diseases 'following-up' is essential.

Maternity and Child Welfare

Throughout the War, attention was rightly directed to improving as well as maintaining the health of mothers and young children. In the reception areas the existing health services were expanded, maternity homes were improvised, sick bays were set up for minor ailments, residential nurseries for healthy children, and hostels were provided. The existing maternity and child services, on the whole, were well maintained, and the nutrition of expectant mothers and young children was safeguarded by priority allowances of milk, cod-liver oil and vitamin supplements. All this work saw its reward in the remarkable reduction of the maternal and infant mortality-rates in war-time.

Industrial Health

In various ways the health of the industrial worker was safeguarded by the Factories (Medical and Welfare Services) Order of the Ministry of Labour and National Service, by the application of the results of medical research to his protection, and by the appointment of medical officers and nurses in armament and munition factories. There is still need for the more comprehensive development of industrial health services.

Laboratory Services

To provide a new service where needed and to strengthen existing services, the Emergency Public Health Laboratory Service was established by the Medical Research Council in collaboration with the Ministry of Health. It offered greatly increased diagnostic facilities, soon proved its permanent value and has become an integral part of the public health service of Britain. The Hospital Laboratory Service set up by the Emergency Medical Service promoted and extended pathological facilities to hospitals throughout the country. Of allied interest was the Blood Transfusion Service, controlled by the Ministry of Health and the Medical Research Council, which saved many lives of soldiers and civilians. Otherwise, the air-raid lists of fatal casualties would have been much heavier.

Nutrition

At the outbreak of war, the Ministry of Food was set up with wide executive powers for the purchase, distribution and rationing of food. Rationing was based on the principle that all the essential foods should be equally available to everyone to an extent necessary to maintain health and at controlled prices. During the War a continuous watch was kept on the nutritional state of the people. There were dietetic and clinical surveys, while the Oxford Nutritional Survey, in association with the Ministry of Health and the Medical Research Council, investigated nutritional problems and added to scientific knowledge. On the whole, national rationing worked well in an unprecedented time of great difficulty and has been an important contribution to the maintenance of good health.

Civil Defence

The emergency hospital medical organisation was designed principally to deal with air-raid casualties and to provide for an outflow of wounded from receiving hospitals in the dangerous areas to hospitals in the periphery and to others still more remote. In practice, the method proved highly successful. The emergency hospitals were also used to a large extent to accommodate chronic sick, who were found in shelters and rest centres in the London area, and for people who needed to be evacuated from the coastal areas in view of the possibility of invasion. The Civil Defence organisation of Britain stood up nobly to the enemy's repeated onslaughts. The public health and medical work done by medical officers of health, doctors, nurses, sanitary inspectors, health visitors and others was beyond all praise. For example, the bombardment of water-mains and sewers involved great risk of outbreaks of enteric disease, yet, owing to the precautions taken, no cases of enteric fever occurred which could be assigned to this cause. A high tribute must be paid to the efficiency of the ambulance service and to the courage, zeal and resourcefulness of the drivers, many of whom were young women.

This satisfactory record of national health during six years of war was a great contribution to national defence, for many wars have been lost by disease and pestilence. The conditions, under Providence, which achieved so excellent a result were: (1) the work of organised public health, environmental hygiene and the health services; (2) nutrition; rationing was ably done by the Ministry of Food with expert medical advice, and the advances made in recent years of knowledge of the adequate principles of nutrition were well utilized; (3) the special arrangements for war emergencies, air-raid precautions, the Emergency Medical Service, evacuation, the comprehensive laboratory organisation, the blood transfusion service and other triumphs of administrative and scientific organisation. Finally, the years of the War and those immediately preceding it had seen great advances in medical science, especially in chemotherapy.

NEWS and VIEWS

American Scientific Mission for London

A SCIENTIFIC mission is to be established in the U.S. Embassy in London to direct the exchange of scientific information and personnel between the United States and Great Britain. It will consist of a small group of scientific men and engineers, headed by Prof. Earl A. Evans, jun. Its activities will cover fields of organic chemistry, biochemistry, physics, biology and agronomy. Mr. John R. Steelman, assistant to Mr. Truman, in a letter to Mr. Herbert Morrison, Lord President of the Council, expressed the hope that the United States would set up scientific missions in other countries in the future. Mr. Steelman explained that the establishment of scientific missions was one of the recommendations included in a series of five reports on science and public policy which he had prepared. The principal objects of the U.S. scientific mission in London will be to facilitate the exchange of scientific personnel and information between the United States and Great Britain; to develop and maintain close personal contact with British Government agencies and other research institutions in the United Kingdom; to answer inquiries originating with the United States Government Departments and scientific agencies in the United States with respect to particular developments in Great Britain; and to stimulate exchange of scientific and technical reports.

Prof. Earl A. Evans, who is thirty-seven years of age, has been professor and chairman of the Department of Biochemistry in the University of Chicago since 1942. He is already known in Great Britain, for he worked at Sheffield during 1940–41 while holding a Rockefeller fellowship, and he is a member of the Biochemical Society of Great Britain. Educated at Johns Hopkins University and Columbia University, he joined the staff of the University of Chicago in 1937 as an instructor of biochemistry. He has carried out work on the chemistry of insulin, the intermediary metabolism of carbohydrates, and radioactive isotopes.

University College of Wales, Aberystwyth

CELEBRATIONS to mark the seventy-fifth anniversary have taken place in the University College of Wales, Aberystwyth, and have included the inaugural lecture of the session and a commemoration service, as well as a series of gatherings for athletic and social activities. The College was founded by men of great vision and faith whose first meetings were held in London in 1869 in Mitre Court and in the Freemasons' Tavern off Fleet Street. They decided to launch a scheme for the foundation of the University of Wales, and in October 1892 the present College at Aberystwyth was opened in a building designed as a hotel and beautifully situated on the shores of Cardigan Bay. Under the principalship of the Rev. Thomas Charles Edwards, twenty-five men students took arts courses; to-day there are more than 1,100 men and women in the College, drawn from all parts of England, Wales and overseas, reading science, arts, music, law and rural science. The hotel buildings have long since proved inadequate, and with the help of many private donors, the College now owns a site totalling about 400 acres, including the Welsh Plant Breeding Station, and adjacent to the National Library of Wales.

The large and distinguished gathering of old students who returned for the seventy-fifth anniversary is a testimony to the widespread influence of their *alma mater*, and there can have been few occasions when one building held such a constellation of principals and vice-chancellors as that which gathered on October 25 for the presentation of degrees, *honoris causa*. The graduands included Sir James Irvine, principal and vice-chancellor of the University of St. Andrews, and Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow, both of whom delivered addresses during the celebrations. On October 26, the commemoration service concluded with a requiem for members of the College who gave their lives in the Great War. The music, written for the occasion by the present principal and the professor of music, was sung by the College choir.

Association of British Science Writers

The Association of British Science Writers was formed on March 3. Its aims are to explain science to the general public; to further the special interests of science writers; to afford the necessary protection when required; to enable science writers to act as a body; to provide facilities, as desired by the members, for general meetings with useful persons possessing material or knowledge of general interest to the Association, or whose interest in the Association is beneficial to its aims and interests; to act, perform or prosecute any other activities from time to time, as and when considered necessary by the members or appointed committee. Membership is open to journalists in the United Kingdom who are bona fide science writers, that is, those who write about science through the media of the Press, dailies and weeklies, journals, magazines and books, etc., and who earn the major part of their income from science writing. The chairman is Mr. J. G. Crowther, science correspondent of the *Manchester Guardian*; and Mr. Maurice Goldsmith, science editor of *Reynolds News*, is the honorary secretary and treasurer. Sir Richard Gregory is the first honorary member of the Association because of the great work he has done in popularizing science. The Association also aims at setting up an associate membership to include those scientists who write regularly about science, but who do not earn the major part of their income from this activity.

Research on Toxicology

The following have been appointed by the Medical Research Council to serve on a new committee to advise and assist in the promotion of research in toxicology, with particular reference to industrial hazards: Prof. G. R. Cameron (*chairman*), Prof. J. H. Gaddum, Dr. Donald Hunter, Dr. F. C. MacIntosh, Dr. E. R. A. Merewether, Prof. R. A. Peters, J. Davidson Pratt, Dr. J. R. Squire, Dr. J. Walker and Dr. J. M. Barnes (*secretary*).

For carrying out experimental work within the field covered by the Committee, the Council has recently established at the Chemical Defence Experimental Station at Porton (Wilts), by arrangement with the Ministry of Supply, a new Toxicology Research Unit under the direction of Dr. J. M. Barnes. For clinical investigations in this field the Council already has a Department for Research in Industrial Medicine at the London Hospital, under the direction of Dr. Donald Hunter, and an Industrial Medicine Research Unit at the Birmingham Accident Hospital, under the direction of Dr. J. R. Squire. In appropriate circumstances, research in the subject may be promoted by the Council elsewhere, either within its own staff organisation or by means of grants to independent workers.

Soil Surveys in the Caribbean

At the second session of the West Indies Conference, which met in St. Thomas, Virgin Islands of the United States, in February–March 1946, the question of soil surveys in the Caribbean was considered. With the object of obtaining advice on the recommendation, the Caribbean Commission, of which the West Indies Conference is an auxiliary body, appointed a sub-committee of soil scientists representative of French, Netherlands, British and United States territories of the Caribbean and comprising Dr. H. J. Page, principal of the Imperial College of Tropical Agriculture, Trinidad (*chairman*); Mr. D. Blanche, acting head of the Agricultural Service, Martinique; Dr. J. A. Bonnet, head of the Soils Department, Agricultural Experiment Station of the University of Puerto Rico; Prof. F. Hardy, professor of chemistry and soil science, Imperial College of Tropical Agriculture, Trinidad; Dr. H. J. Müller, agricultural chemist, Department of Agricultural Economics, Surinam.

The sub-committee recommended that a Conference of Soil Scientists should be held in Puerto Rico in 1948, under the auspices of the Committee on Agriculture, Nutrition, Fisheries and Forestry of the Caribbean Research Council, for the purpose of studying systems and methods of classification and mapping of tropical soils, with special reference to the standardization of such systems and methods for use in soil surveys throughout the Caribbean region, and to carrying out such surveys as soon as possible. The proposed agenda is: (i) Presentation and discussion of collected data on soil-forming factors of the various territories. (ii) Standardization of field and laboratory methods of soil surveys. (iii) Discussion of different systems of soil classification and mapping. (iv) Formulation of a detailed regional programme of soil surveys. (v) Survey of problems of soil erosion, soil conservation and soil renovation in the different territories. (vi) Practical application of soil surveys to land utilization. It was recommended that attendance at the conference should be as representative as possible, and should include soil scientists who are specially interested in tropical soils from the above-mentioned points of view, not only from the Caribbean, but also from other countries; special reference was made to Cuba, Haiti and the Dominican Republic, and it was recommended that the Governments of these countries should be invited to send representatives to participate in the conference. The recommendations have been approved by the Caribbean Commission, and a working committee has been set up to prepare for the conference, the date of which has not yet been definitely fixed.

The Giant Panda

It has been announced by the Chinese Government that the Szechwan Provincial Government has limited the catching of pandas to one pair every five years. This regulation was made at the request of the Academia Sinica with the view of protecting this rare species from extinction. Few mammals have caused more scientific and lay interest than the giant panda (*Ailuropoda melanoleuca*, David), first made known to science when David sent skins home to France from his travels in western China during 1868–69. Several expeditions attempted to secure live specimens, and in 1937 one was exhibited by the New York Zoological Society, and in the following year another was shown in London. Their similarity to the true bears is not borne out by the skull, which resembles the raccoons, and thus the sub-family Ailurinæ of the raccoons (Procyonidæ) was created for the giant panda and the more numerous lesser panda (*Ailurus fulgens*). It is to be hoped that the lead by the Chinese Government will encourage other Eastern States to curb the activities of collectors, who are likely to exterminate animals of limited distribution.

Education and Training of Laboratory Technicians

A Committee on the Education and Training of Laboratory Technicians was set up by a conference convened in 1946 by the Association of Scientific Workers, the Association of University Teachers and the British Association of Chemists. Among the bodies now represented on it are the Institute of Physics, the Royal Institute of Chemistry, the Biological Council, the Institute of Medical Laboratory Technology and the Science Masters' Association, in addition to the three Associations that convened the conference; there are also representatives of industry and a number of senior laboratory technicians on the Committee; representatives of other organisations concerned with the problem, including the Ministry of Education, are being coopted. The chairman of the Committee is Prof. F. R. Winton and the honorary secretary is now Dr. H. J. T. Ellingham (secretary, Royal Institute of Chemistry). The attention of the Committee has been directed essentially to that important class of technicians, which includes laboratory stewards and, at the highest level, laboratory superintendents, whose work is vital to the maintenance and operation of research laboratories in industrial organisations, research associations and academic institutions and of laboratories for the instruction of students in universities, technical colleges and schools. Their work involves experience of techniques derived from a number of branches of science and technology; most of them are to be regarded not as potential chemists, physicists, biologists, etc., but as potential first-class laboratory technicians. So far, however, few courses have been provided for the training of technicians of this type, nor is there any qualification in their own field to which they may aspire. The Committee is therefore engaged in preparing syllabuses for the certificate and diploma stages of a general course of training for such laboratory technicians, based on proposals put forward by a sub-committee consisting of the laboratory technician members of the Committee. It is hoped to start a trial course early in 1948. In the meantime, it is understood that a representative group of laboratory technicians who have been associated with the work of the Committee are taking steps to constitute a professional qualifying body similar in many respects to the Institute of Medical Laboratory Technology.

Thermo-nuclear Reactions under Terrestrial Conditions

The possibility of initiating thermo-nuclear reactions under terrestrial conditions is discussed by Dr. J. H. J. Poole (*Proc. Roy. Dublin Soc.*, **24**, 71; 1946). It is pointed out that the results obtained by Atkinson, Gamow and Teller, Bethe and others, in their investigations of thermo-nuclear reactions as applied to stellar conditions, are equally valid for terrestrial conditions. In applying these results to the sea, which is the largest known source of thermonuclear energy on the earth, four types of reactions need to be considered. They are proton-proton, proton-deuteron, and two forms of deuteron-deuteron reaction. The deuteron-deuteron reaction is shown to be the most important, by comparing the values of the rate of generation of thermo-nuclear energy derived for the several reactions. The question whether it is possible to initiate and maintain a thermo-nuclear reaction in the sea is discussed by considering the case of a sphere of water in which thermo-nuclear energy is being generated and which is radiating as a black-body. It is shown that the minimum radius of such a sphere must be of the order of 3×10^6 km., so that there would seem to be very little danger of starting a world-wide explosion by dropping an atom bomb into the sea. (Dr. Poole's paper was written prior to the Bikini atom bomb tests.) If the sphere consisted entirely of heavy water, the minimum radius is reduced to 3·6 km., so that even in this extreme case a self-maintained thermo-nuclear explosion would be unlikely to be started by an atom bomb. It is probable, however, that if heavy water were incorporated in the bomb, with some of the energy liberated in the explosion being derived from deuteron reactions, more complete fission of the active heavy-element constituent would be ensured by the neutrons emitted by the reaction.

Catalogue of Laboratory Equipment

In the days before the War, the comprehensive catalogues of the laboratory furnishing firms were the 'bibles' of all those concerned with the ordering and purchasing of laboratory apparatus and instruments. The long years of abnormal circumstances and particularly of paper shortages have deprived laboratory workers of these ready and compact sources of information covering the whole range of scientific laboratory equipment. It is therefore heartening as a foretaste of more normal conditions that Messrs. Griffin and Tatlock, Ltd., have been able to issue a new and very substantial catalogue of scientific apparatus, and that the familiar, but out-of-date, pre-war publication of this firm, which for so long has been indicative of what might once have been obtained, can be replaced by this new list of what is now available. It is obvious from the contents of the catalogue that the scientific apparatus industry of Great Britain has not only completed the transition from war to peace manufacture, but has also expanded its range of products to cover gaps in its production which existed before the War; every article in this most comprehensive list of scientific apparatus is made either by the firm itself or by some other British manufacturer. The catalogue is an attractive publication, and in its arrangement due attention has evidently been paid to the convenience of the user. The catalogue is divided into thirteen sections, each dealing with the apparatus and instruments required for the teaching and experimental work of a particular subject in university and other educational laboratories. In addition, there are a list of chemicals and reagents and a very full index. One very useful aspect of the catalogue is the full description given of many of the items, together with articles on the methods and theory of use. Messrs. Griffin and Tatlock are to be congratulated on this praiseworthy effort.

Publication of Papers on Physics

Prof. E. N. da C. Andrade, in his presidential address to the Physical Society in 1945, referred to the "need of a medium for the publication of original papers on physical problems whose main interest was industrial and technical" (*Proc. Phys. Soc.*, 57, 21; 1945). To meet this need the Board of the Institute of Physics and the Council of the Physical Society have proposed the introduction of a new journal of applied physics, which, it is hoped, will commence early in 1948. A journal of about 400 pages a year, issued quarterly, is contemplated, devoted to applications of physics, containing papers on original work in technical physics, border-line papers on subjects which are not strictly 'fundamental' physics, reviews of recent advances, discussions, and, probably, editorials, notices of meetings and news items. A Joint Advisory Panel, on which every Group of the Society and all the Groups and local Branches of the Institute will be represented, is to be set up to work out the details. The rate of subscription to the new journal will, at first, be one guinea a year to members of the Society or Institute, and about 30*s.* to non-members.

In his address, Prof. Andrade pointed out also that the increased number of papers communicated to the Physical Society for publication would necessitate issuing two volumes a year of the *Proceedings* instead of the present one. The Council has accordingly announced that, from January 1948, the *Proceedings* will appear in two volumes a year, each consisting of six parts issued monthly, in order that the period between the communication and publication of papers may be reduced. In spite of the title *Proceedings*, a change of which was recently proposed but rejected by the members, papers are published in the Society's journal which are not necessarily a part of the proceedings of meetings. It is felt that, as many Continental physical journals ceased publication during the War and have not yet reappeared, Continental physicists may find a medium for the publication of their work in the Society's journal, now that more space and more rapid publication are assured.

Paper for Technical Journals

Mr. H. Wilson, president of the Board of Trade, replying to Mr. Erroll in the House of Commons on October 30, said that steps are being taken to ensure to journals devoted primarily to original research their full requirements of paper, and he hopes to exempt technical periodicals from the reduction which it is necessary to make in the paper available for periodicals generally.

Breeding of the Moustached Warbler in Britain

Conclusive evidence produced by R. A. Hinde and A. S. Thom (*British Birds*, 40, No. 4; April 1947) shows that the first recorded breeding of the moustached warbler (*Lusciniola melanopogon*) in the British Isles took place in Cambridgeshire in 1946. The evidence was compounded from observations made by a group of distinguished ornithologists, and the dark crown and superciliary stripe, as well as the cocking of the tail, leave no doubt that this Mediterranean bird, the nearest part of whose normal range is the south of France and whose sole previous claim to a place in the British list rested on a single occurrence, must now be added to the list of birds which have been known to breed in Britain.

Swiss Earthquakes during 1945

This annual seismological report of the Swiss observatories has been compiled by Dr. E. Wanner of Zurich. Seismographs are installed at the Swiss Observatories of Zurich, Chur, Neuchâtel, Basel and Brig, and during the year 85 near earthquakes and 189 strong distant earthquakes were registered. There were ten earth tremors with epicentres in Switzerland which were felt by people during the year. None of these had a greater intensity than V on the Rossi-Forel Scale, so that none reached destructive intensity. The greatest three tremors were (1) May 13 at Freiburg, (2) October 13 at Engadine and (3) November 10 at Wildhorn.

Science in the U.S.S.R.

A symposium on "Science and the Soviet State" in honour of the thirtieth anniversary of the U.S.S.R. is being organised by the Science Section of the Society for Cultural Relations with the U.S.S.R., 14 Kensington Square, London, W.8. The chairman of the meeting, which will be held at the Caxton Hall, London, S.W.1, on November 12, at 6.30 p.m., will be Sir Robert Watson-Watt, and speakers will include Prof. J. D. Bernal on "The Scientist as Citizen", Prof. V. Gordon Childe on "Archæology and the State", and Mr. Andrew Rothstein on "Science and Economic Planning". Tickets for the meeting (2*s.* 6*d.* each) can be obtained from the Society for Cultural Relations.

Medical Sub-section of the Library Association

The inaugural meeting of a new Medical Sub-section of the Library Association was held at Chaucer House on October 4. The following committee was appointed to manage the affairs of the group: C. C. Barnard, London School of Hygiene and Tropical Medicine (*chairman*); Miss E. Wigmore, Medical Research Council; W. A. Lee, Liverpool Medical Institution; W. R. Le Fanu, Royal College of Surgeons of England; T. J. Shields, British Medical Association; G. Wilson, Medical Library, University of Manchester; and W. J. Bishop, Wellcome Historical Medical Museum, 28 Portman Square, London, W.1 (*hon. secretary*).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fractional Precipitation of Serum Proteins

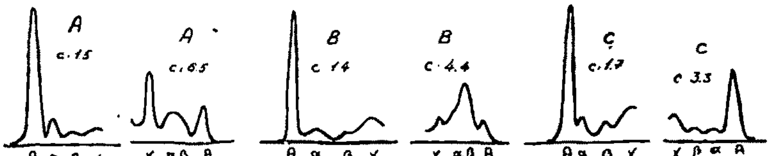
In a recent note[1], we described the purification of renin by means of a fractional precipitation with protein-precipitating agents (sulphosalicylic acid and tungstic acid). In order to test the adaptability of this method, we have investigated the fractional precipitation of blood serum using electrophoresis (Tiselius) for analysing the composition of the products isolated. The most important of the results so far obtained is that it is possible, if we choose the right conditions and suitable precipitating agents, to perform the fractionation with a high degree of selectivity.

(*A*) To 40 ml. ox serum diluted with 40 ml. phosphate buffer (*p*H 7·6) was added 1·22 ml. *M* sodium tungstate and then precipitated with *N* hydrochloric acid until it reached *p*H 6·8. The accompanying electrophoresis curves show a large amount of γ-globulin in the precipitate, considerably less of a component containing α- and β-globulin and only small amounts of albumin. In the filtrate large amounts of albumin, some α-globulin but almost no β- and γ-globulin remained.

(*B*) To 19 ml. ox serum diluted with 19 ml. phosphate buffer (*p*H 7·6) was added 10 per cent sulphosalicylic acid until it reached *p*H 4·0. In the filtrate large amounts of albumin, some γ-globulin but almost no α- and β-globulin remained. The precipitate contained a small amount of albumin, a very large amount of α-globulin, a considerable amount of β-globulin but almost no γ-globulin.

(*C*) To 20 ml. ox serum diluted with 20 ml. phosphate buffer (*p*H 7·6) was added 0·7 ml. *M* uranyl nitrate and solid bicarbonate until the precipitate was again dissolved (about *p*H 8); then *N* hydrochloric acid until it reaches *p*H 6·3. The compositions of filtrate and precipitate are almost identical and correspond to the composition of the original ox serum.

These three examples show the very conspicuous dissimilarity in the products obtained when different conditions and precipitating agents are used. While the uranyl nitrate evidently precipitates the different components to almost the same degree, tungstic acid precipitates chiefly the γ-globulin, and sulphosalicylic acid mainly α- and β-globulin. The only case known to us in which a similar procedure has been used previously is the precipitation of inert proteins from mare serum gonadotrophin by means of sulphosalicylic acid[2] or metaphosphoric acid[3]; but here the bulk of proteins is removed and only a very small amount, containing the active substance, remains in the solution.



Fractional precipitation of ox serum with (*A*) tungstic acid, (*B*) sulphosalicylic acid, and (*C*) uranyl nitrate. *c* denotes the concentration of the solution investigated in relation to the original serum. Left-hand members of pairs, filtrates; right-hand members of pairs, precipitates

By changing the conditions of precipitation (*p*H, salt concentration, dilution, temperature) and the nature of the agents used for formation of the slightly soluble protein compounds, it is possible to modify this method between much wider limits than the methods usually employed in protein fractionation.

This work was aided by a grant from the Teknisk-kemisk Fond; it is being continued and the results will be published elsewhere.

Tage Astrup
Aksel Birch-Andersen

Biological Institute,
Carlsberg Foundation,
Copenhagen, N.
July 15.

[1] Astrup, T., and Birch-Andersen, A., [*Nature*, **160**, 570 (1947)].

[2] Rinderknecht, H., Noble, R. L., and Williams, P. C., *Biochem. J.*, **33**, 381 (1939).

[3] Rimington, C., and Rowlands, I. W., *Biochem. J.*, **35**, 736 (1941).

Constitution of Salmine

It has recently been suggested[1] that salmine may be a cyclic peptide because it does not appear to contain any free carboxyl groups when these are estimated by the methods of Fraenkel-Conrat[2] and Herriot *et al.*[3]. This suggestion is in direct contrast to the findings obtained in the present work, to be fully reported elsewhere. A complete amino-acid analysis of salmine sulphate suggests a molecular weight of 8,000 and a peptide chain of 58 residues:

Amino-acid	Amino-acid N as % protein	Amino-acid/100 gm. protamine	Min. mol. wt.	No. of residues	Calc. mol. wt.
Arginine	89·0	85·2	204	40	8160
Isoleucine	0·56	1·61	8140	1	8140
Valine	1·20	3·1	3770	2	7540
Proline	2·29	5·8	1980	4	7920
Glycine	1·78	2·94	2550	3	7650
Alanine	0·56	1·10	8100	1	8100
Serine	3·94	9·1	1152	7	8050
	99·33	108·85		58	7930

The protamine sulphate contains 19·85 per cent H_2SO_4 (40 equivalents per molecule), being sufficient to combine with all the arginine residues in the molecule. The amino-acids reported by Block and Bolling[4] have been confirmed, by isolation as acetyl derivatives; in addition, glycine has been shown to be present in the protamine.

End group analysis by the method of Sanger[5] (Porter, private communication) has shown that proline occupies the terminal imino position. There is no reason to suppose that the procedure of Sanger has resulted in the opening of a cyclic peptide, since a similar procedure carried out on gramicidin-*S*[6] showed that this material was indeed a cyclic peptide.

It seems reasonable to assume that salmine is a normal peptide, and that the methods used by Fraenkel-Conrat and Olcott[1] are not applicable to a protein with such singular properties as salmine.

G. R. Tristram

Biochemical Laboratory,
Cambridge. July 15.

[1] Fraenkel-Conrat and Olcott, *Fed. Proc.*, **6**, 253 (1947).

[2] Fraenkel-Conrat and Olcott, *J. Biol. Chem.*, **161**, 259 (1945).

[3] Herriot, Anson and Northrop, *J. Gen. Physiol.*, **30**, 185 (1946).

[4] Block and Bolling, *Arch. Biochem.*, **6**, 417 (1945).

[5] Sanger, *Biochem. J.*, **39**, 507 (1945).

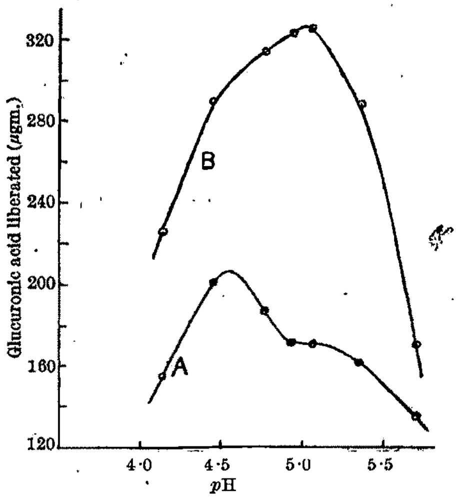
[6] Sanger, *Biochem. J.*, **40**, 261 (1946).

β-Glucuronidase Activity of Ox Spleen

β-GLUCURONIDASE was first prepared from ox kidney by Masamune[1] and later from ox spleen by Fishman[2,3] and Graham[4]. Each of these workers, using *l*-menthylglucuronide as assay material, indicated that only one glucuronidase was present. Talalay, Fishman and Huggins[5], using phenolphthalein-glucuronide as substrate, came to a similar conclusion.

A re-investigation of the method of preparation and purification of β-glucuronidase from ox spleen revealed that the problem was not so simple as previously indicated. A crude glucuronidase extract from ox spleen was analysed by the 'variable solvent solubility' test as defined by Falconer and Taylor[6] at *p*H 5·0, using ammonium sulphate as precipitant. The results of this test indicated that two protein fractions having glucuronidase activity existed in this crude extract. Similar results were obtained in a test carried out at *p*H 7·0. At *p*H 6·0, however, only one fraction was apparent.

Using the data obtained in these experiments, the crude glucuronidase extracts were fractionated with ammonium sulphate at *p*H 5·0 and the two fractions separated, which on further purification gave the *p*H activity curves shown in the accompanying graph. *l*-Menthylglucuronide and acetate buffers were used in these experiments.



*p*H ACTIVITY CURVES OF THE ENZYMES OBTAINED BY FRACTIONATION, USING DATA OBTAINED IN SOLUBILITY TESTS. ASSAYS USING 0·1 *M* ACETATE BUFFERS AND 0·01 *M* *l*-MENTHYLGLUCURONIDE

A, fraction precipitated between 1·26 and 1·54 *M* $(NH_4)_2SO_4$
B, ,, ,, ,, 1·54 and 1·76 *M* $(NH_4)_2SO_4$

Fishman[2], in his experiments, fractionated the ox spleen extracts between 37 and 50 per cent saturation ammonium sulphate, and Graham[4] used the limits 36 and 46 per cent saturation. From the data obtained in the solubility tests, it is obvious that these two workers eliminated the glucuronidase having an optimum *p*H of 4·5 for the hydrolysis of *l*-menthylglucuronide, since the limits of precipitation with ammonium sulphate are 31·5–38·5 per cent saturation for this enzyme, and 38·5–44 per cent saturation for the enzyme having an optimum *p*H at 5·0.

Preliminary results appear to indicate that the relative amounts of these two enzymes vary in different extracts, rendering inaccurate, therefore, glucuronidase assays using only one *p*H value.

Full details of these experiments will be published later in the *Biochemical Journal*.

G. T. MILLS

Biochemistry Department,
St. Thomas's Hospital Medical School,
London, S.E.1.
July 1.

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[1] Masamune, H., *J. Biochem., Japan*, 19, 353 (1934).

[2] Fishman, W. H., *J. Biol. Chem.*, 127, 367 (1939).

[3] Fishman, W. H., *J. Biol. Chem.*, 131, 225 (1939).

[4] Graham, A. F., *Biochem. J.*, 40, 603 (1946).

[5] Talalay, P., Fishman, W. H., and Huggins, C., *J. Biol. Chem.*, 166, 757 (1946).

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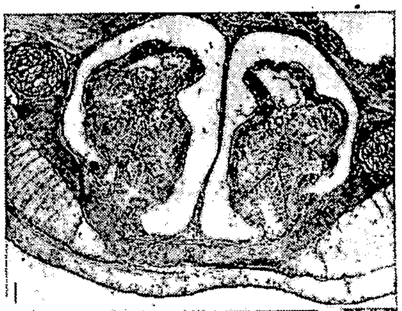
Effect of Thiourea on the Endostyle of Ammocœtes

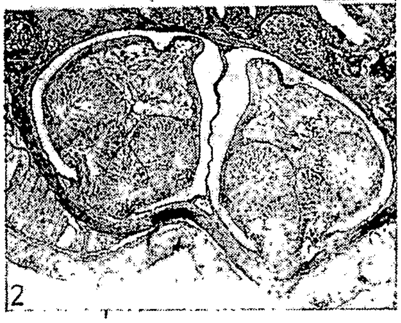
RESULTS of recent investigations[1–3] have directed attention to a group of drugs which produce hypothyroidism and hyperplasia of the thyroid gland in rats, mice and dogs. These drugs include sulphonamides and various derivatives of thiourea and of thiouracil. Inhibition of amphibian development by thiourea[4] and by thiouracil[5] has been reported.

Like the amphibians, the lamprey (*Petromyzon fluviatilis*) undergoes metamorphosis; on account of this and because the exact function of the endostyle is still a matter for conjecture, a preliminary experiment was carried out to find the effect, if any, of thiourea on the endostyle of the ammocœte.

Four ammocœtes were kept in a solution of 0·033 per cent thiourea in tap water, with mud and waterweed, which was aerated by means of a pump. The solution was changed every day. The animals were killed on the eleventh day. Four other ammocœtes were kept as controls under similar conditions in tap water and killed on the eleventh day. They were all fixed in Bouin's fluid and the sections were stained with hæmatoxylin and orange G.

As a result it was found that in the endostylar glands of the controls there were many vacuoles and the nuclei of the cells were unevenly distributed (Fig. 1); whereas the endostylar glands of the





thiourea-treated ammocœtes showed an absence of large vacuoles and the nuclei were basally placed (Fig. 2).

R. P. Jones

Physiological Laboratory,
Trinity College,
Dublin.
June 20.

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[3] Astwood, E. B., *J. Pharm. and Exp. Therap.*, 77, 79 (1943).

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Stabilization of Penicillin-Salt Solutions with Sodium Citrate

In a recent paper[1], I described the stabilizing effect of sodium citrate dissolved in physiological salt solution on the rate of destruction of sodium penicillin solutions by heat. Only very dilute concentrations of sodium penicillin (1–5 units per ml.) were used.

The present communication deals with the effect obtained with higher concentrations; 100, 1,000 and 3,000 u./ml. were tested and the optimal molar concentration of sodium citrate assessed.

Method. The agar-cup method as described in my previous paper was used. The average of at least three assays was compared with the standard curve constructed daily.

Results. (1). Solutions containing 100 and 1,000 u./ml. sodium penicillin (T.R.C. tabl. 392) were made up with sodium citrate solutions ranging from $M/20$ to $M/600$. The optimal effect was obtained with $M/400$ at pH 5·6 and solutions (*a*) in $M/400$ sodium citrate, (*b*) in distilled water adjusted to the same pH with phosphate, and (*c*) in one test with distilled water pH 4, were heated at 100° C. The results were as follows:

	Percentage of penicillin remaining				
at 100° C.	100 u./ml.			1,000 u./ml.	
after	(*a*)	(*b*)	(*c*)	(*a*)	(*b*)
15 min.	75	75		100	100
30 ,,	60	70	37	80	80
45 ,,	50	35		80	56
60 ,,	25	12·5		80	48

It will be noted that the rate of destruction of sodium penicillin by heat was about the same in (*a*) and (*b*) up to 30 min., but higher in (*c*). After 45 and 60 min. the sodium citrate effect exceeds that of buffered distilled water.

(2) 3,000 u./ml. sodium penicillin T.R.C. 392 dissolved (*a*) in $M/1,000$ citrate solution pH 6·4 and (*b*) in distilled water adjusted to pH 6·3 with phosphate gave the following results after boiling:

	Percentage remaining	
min.	(*a*)	(*b*)
50	65	50
75	48	40
150	17	10

(3) *Stabilization at room temperature.* Ampoules were filled with penicillin salt solutions, then kept at 100° C. for 15 minutes and afterwards at room temperature. The samples remained sterile as proved by several tests for sterility. The solutions contained: (*a*) 10,000 u./ml. sodium penicillin (The Distillers Co., Ltd., Liverpool) (915 units per mgm.) in $M/500$ citrate solution, (*b*) the same in $M/1,000$ citrate solution:

Percentage of penicillin remaining		
after days	(*a*)	(*b*)
21	80	80
28	59	63
35	41	48

A solution containing 1,000 u./ml. sodium penicillin T.R.C. 330 dissolved in distilled water lost 82 per cent of its potency after twenty-five days.

L. Hahn

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[1] *Lancet*, i, 408 (1947).

Microbiological Oxidation of Cholesterol with *Azotobacter*

L. Mamoli and A. Vercellone[1] were the first to work with the microbiological oxidation of sterols. They carried out investigations principally in a series of sex hormones, and with the aid of Coryne-bacteria, cultivated together with yeast, oxidized steroid alcohols to ketones. Recently, G. E. Turfitt[2] found identical results with certain species of *Proactinomyces*.

At the beginning of our work we also used *Proactinomyces*; but we found that the species we isolated were capable only to a small degree of transforming steroid alcohols to ketones (in our experiments, principally cholesterol). We carried out our further investigations with a species of *Azotobacter* and observed the following results:

(1) The transformation of cholesterol to cholestenone was much more successful with *Azotobacter* than with our species of *Proactinomyces*.

(2) Besides the dehydration of the oxy-group, the *Azotobacter* also dehydrates within the sterol ring; thus from the reaction product we succeeded in isolating 7-dehydrocholesterol.

(3) Parallel to dehydration, a stronger oxidation of the cholesterol also took place, as after the process methylheptanone was also formed, from which the splitting off the side-chain could follow.

Our experiments were carried out in the following way. Cholesterol was dispersed in a rich synthetic culture medium of saccharose. The mixture was sterilized and added to the *Azotobacter* culture. A lively fermentation began, which lasted for three–four days, then gradually diminished. On the fourteenth day, after weak alkali hydrolysis, it was extracted with benzene. From the residue of the extract unchanged cholesterol was regained, then the methylheptanone was obtained by vapour distillation. The cholestenone was isolated through its semi-carbazone, and the 7-dehydrocholesterol by chromatographic adsorption.

Our experiments also support the hypothesis[3] according to which 7-dehydrocholesterol in the organism results from an enzymatic action on cholesterol.

The determination of the *Azotobacter* species, as well as the identification of the product formed by the splitting off of the side-chain, are in hand. The experiments also aim at ascertaining the effect the *Azotobacter* species exercises on certain substances of the sterol series.

J. Horváth
A. Krámli

Hungarian Biological Research Institute,
Tihany. July 12.

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[1] Mamoli and Vercellone, *Ber. dtsch. chem. Ges.*, 70, 470, 2079 (1937); 71, 1686 (1938).

[2] Turfitt, *Biochem. J.*, 38, 492 (1944); 40, 79 (1946).

[3] Schönheimer, Behring, Hummel and Schindel, *Z. physiol. Chem.*, 192, 73 (1930).

A Modified Microbiological Assay Procedure

At a joint meeting of the Biochemical Society and the Society for General Microbiology, the principles underlying microbiological assay were discussed in some detail[1]. The advantages of measuring bacteriological growth directly, thus avoiding the need to pass the lag period before making indirect measurements of growth, such as acidimetry, are offset by the greater complexity of apparatus and technique needed in the more direct ones, such as turbidimetry.

During the discussion at the meeting, I suggested that it might be possible to make the best of both worlds by applying in reverse to the assay of vitamins and amino-acids the principles now very generally adopted for the assay of penicillin and other antibiotics. In other words, the medium would be devoid of the vitamin to be estimated and would be inoculated with the chosen strain of organism, graded amounts of the vitamin being then pipetted into suitably formed cups, using the ordinary Petri dish and agar medium as in the Heatley test and its various modifications. This should result in a circular area of growth round the cup, that is, in a 'zone of exhibition'.

It was not possible to investigate this matter for some time after the meeting mentioned; but Dr. W. F. J. Cuthbertson in these Laboratories has now been able to do so. We find that the zones are, indeed, graded to dose, being over a fairly wide range proportional in diameter to the logarithm of the amount of the test vitamin in the cup. The method seems to work not only for riboflavine and aneurine, on two different media, but also for several other vitamins of the *B* group.

Among the several advantages of this method, which may be of wide application, there are two outstanding ones. In the first place, it puts at the disposal of the microbiological assayist a far wider range of organisms than hitherto, for he is no longer restricted to those that produce acid. This may mean, in effect, that he can bring into use for analytical purposes some of the less-exacting organisms that are known to require only one or two organic nutrients, apart from a source of carbohydrate with the usual mineral salts. The second outstanding advantage is speed, for it has been found not merely possible but desirable to use media and techniques giving maximum growth in less than 24 hours. The Petri dish procedure, furthermore, besides making replication easy, lends itself very well to tests of factorial design with subsequent analysis of variance in their statistical treatment. The chief disadvantage encountered is that, in comparison with the acidimetric technique in test tubes, considerably higher concentrations must be used, and the method as at present carried out cannot be applied to, for example, the estimation of riboflavine in flour and other wheat products.

Further work on the test is in hand, and it is hoped to publish a more detailed account at a later date.

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Sept. 16.

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[1] *Biochem. J.*, 41, i (1947).

Escape of Thoron from Thorium X Salts

THE absorption method devised by several authors[1,2,3] for obtaining the relative amounts of radium, mesothorium and radiothorium in the mixed salts of these elements in terms of their gamma-ray equivalent has been used for some sixteen sources of this kind destined for a radium mass-unit.

In fifteen of these sources the salts, forming a sphere 5 mm. in diameter and enclosed in a steel tube with walls 1 mm. thick (Fig. 1), emit gamma rays equivalent to 180 mgm. of radium, from which about 34 per cent belong effectively to the gamma rays of radium B + C, 33 per cent to mesothorium 2 and 33 per cent to thorium C + C″.

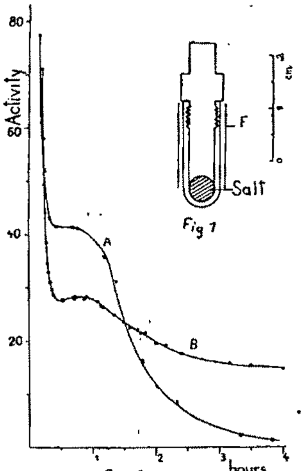

Fig 1

Fig 2

As several of these tubes leaked considerably after they had been sealed, an attempt was made to compare the amount of the escaping radon to that of the thoron by means of their active deposits. We hoped to obtain in this way some information concerning the relation between the parent elements of these two emanations.

In the first experiment the leaky container was exposed for 1 hour in an air-tight vessel (volume 1·5 l.) filled with air at normal pressure. After exposure, the air of the vessel was passed into an evacuated ionization chamber, measured with a bifilar electrometer, and after a total time of 5 min. in the chamber removed and replaced by inactive dry air. The activity of the air amounted to several microcuries.

The residual activity of the chamber after the active air has been removed gave a typical curve (*A*, Fig. 2) of the radon-active deposit of rapid change, with no trace of the thoron-active deposit.

This experiment has been repeated in a different manner. When filling the ionization chamber the air current was passed directly upon the tube with radioactive salts enclosed in a glass tube of slightly larger diameter. With other conditions identical with those of the previous experiments, the residual activity of the ionization chamber (curve *B*, Fig. 2) gave after four hours the well-known plateau of the active deposit of thoron.

In order to find if the thoron is able under normal conditions to escape from the tube at all, a tin-foil (*F*, Fig. 1) was wrapped directly on the tube and left there for 5 min. The activity of the tube was then measured by means of alpha rays. A decay curve of exactly the same shape as curve *A* was obtained, which is decisive proof that no thoron whatever escapes from the tube containing radioactive salts.

Even with regard to the short half-life period of thoron (54·5 sec.) these results are surprising. They show (1) there is no leakage of thoron from the unsealed radiothorium containers when exposed in the free air; (2) to remove the thoron from the radiumthorium salts a notable difference between the pressure of the surrounding air and of the air enclosed with the salts is necessary.

In the light of these results, the assertions of several workers[4] that there exist atoms of thoron-active deposit in the atmosphere, based only on the measurements of the activity of a negatively charged wire exposed in the free air, need revision.

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Department of Physics,
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July 7.

[1] Hahn, O., *Le Radium*, **11**, 71 (1914).

[2] Bothe, W., *Z. Phys.*, **24**, 10 (1924).

[3] Sievert, R. M., and Olsson, E., *Acta Radiol.*, **12**, 121 (1931).

[4] Meyer, S., and Schweidler, E., "Radioaktivität" (2nd Edit., 1927) 575.

Crystal Structure of Hydroxylammonium Chloride and Bromide

HYDROXYLAMMONIUM chloride, NH_3OHCl, and hydroxylammonium bromide, NH_3OHBr, are isomorphous and belong to the space group $C_{2h}^5 - P2_1/c$. The unit dimensions are

NH_3OHCl $a = 6{\cdot}94$ kX., $b = 5{\cdot}94$ kX., $c = 7{\cdot}68$ kX., $\beta = 120{\cdot}8°$
NH_3OHBr $a = 7{\cdot}28$ kX., $b = 6{\cdot}12$ kX., $c = 8{\cdot}03$ kX., $\beta = 120{\cdot}8°$

The unit cell contains 4 NH_3OHX.

The structure was determined by means of one-, two-, and three-dimensional Fourier syntheses. In this way it was possible to determine the parameters with great accuracy, but the electron density data were not sufficient to settle the question as to which peaks corresponded to nitrogen and which to oxygen. The neighbourhood of these light atoms and the distribution of the charges support the following choice, exemplified by the chloride:

4 N in 4(*e*) : $x_1 = 0{\cdot}283$, $y_1 = 0{\cdot}664$, $z_1 = 0{\cdot}222$
4 O in 4(*e*) : $x_2 = 0{\cdot}253$, $y_2 = 0{\cdot}870$, $z_2 = 0{\cdot}106$
4 Cl^- in 4(*e*) : $x_3 = 0{\cdot}233$, $y_3 = 0{\cdot}190$, $z_3 = 0{\cdot}395$

Two NH_3OH^+ groups and two Cl^- are thus situated in the immediate vicinity of each of the planes ($\frac{1}{4}$ y z) and ($\frac{3}{4}$ y z). This layer structure explains the pronounced cleavage parallel to (100). The distance N—O within the same NH_3OH^+ group is 1·45 kX., which is in rather good accordance with the sum of the covalent radii of N and O.

The closest Cl^- neighbours of a nitrogen atom are at distances of 3·16, 3·21, 3·22 and 3·25 kX. This is comparable with the closest approach between Cl^- and the N atom of the $-NH_3^+$ group in geranylamine hydrochloride[1] (3·17–3·24 kX.), methylammonium chloride[2] (3·18 kX.), and hydrazinium dichloride[3] (3·10 kX.). The distribution of these closest four Cl^- neighbours around the N atom is similar to the corresponding distribution in geranylamine hydrochloride[1] and hydrazinium dichloride[3].

The oxygen atoms have the closest two Cl^- neighbours at distances of 2·98 and 3·04 kX. The closest Cl^-—Cl^- approach is 3·91 kX.

A more detailed report will follow elsewhere.

BODIL JERSLEV

Chemical Institute,
University of Uppsala.
June 26.

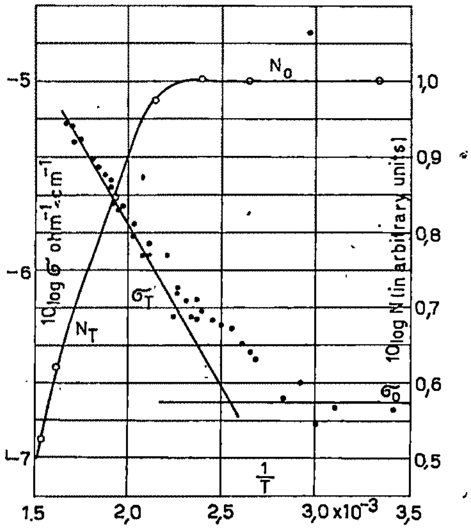
[1] Jeffrey, G. A., *Proc. Roy. Soc.*, A, **183**, 388 (1945).

[2] Hughes, E. W., and Lipscomb, W. N., *J. Amer. Chem. Soc.*, **68**, 1970 (1946).

[3] Donohue, J., and Lipscomb, W. N., *J. Chem. Phys.*, **15**, 115 (1947).

Dielectric Losses and Fluorescence of Zinc Silicate

WHILE investigating a manganese-activated zinc silicate, we have found that the temperature-dependence of the dielectric losses and that of the fluorescence (2537 A. excitation) show an intricate connexion. In the accompanying graph there is plotted the logarithm of the total number of light quanta emitted (*N*) and the logarithm of the electrical conductivity (σ) obtained by measuring the dielectric losses at 20 Mc. (without ultra-violet irradiation) as a function of the reciprocal absolute temperature.



At lower temperatures the fluorescence and the conductivity can be considered as constant (N_0 and σ_0 respectively). At higher temperatures, however, the fluorescence shows a sudden decrease (N_T), while the conductivity (σ_T) increases, giving a straight line in our co-ordinate system.

$$\log \sigma_T = \log A - B/2kT. \qquad (1)$$

In eq. (1), *A* is practically constant over the temperature-range of our investigations, though theoretically it should be slightly temperature-dependent; *B* is an activation energy, giving the distance between electron donator and acceptor zones; *k* is Boltzmann's constant; and *T* denotes the absolute temperature. Below a critical temperature (approx. 445° K.) the observed conductivity values indicate a deviation from the law mentioned above, showing a gradual transition into the temperature-independent conductivity (σ_0). The resulting conductivity is, therefore,

$$\sigma \doteq \sigma_0 + \sigma_T = \sigma_0 + A \exp. (- B/2kT). \qquad (2)$$

The numerical values for our zinc silicate sample are: $\sigma_0 = 0{\cdot}2 \times 10^{-6}$ ohm^{-1} cm.$^{-1}$, $A = 5{\cdot}4 \times 10^{-3}$ ohm^{-1} cm.$^{-1}$ and $B = 0{\cdot}7$ eV.

From these observations, we deduce that the ultimate absorption of the ultra-violet radiation takes place in centres, the number of which is in close relation to the electrical conductivity. Assuming that at temperature T the mobility of the carriers of electricity is the same for σ_0 and σ_T, the total number of carriers is $c_1(\sigma_0 + \sigma_T)$, whereas the number of absorption processes is $c_2(\sigma_0 + \alpha\sigma_T)$, where c_1 and c_2 are constants and α is the absorption coefficient for the σ_T centres, taking the absorption coefficient for σ_0 centres as unity.

The ultra-violet quanta absorbed by σ_0 centres give rise to the emission of the same number of fluorescent light quanta, whereas the absorption by a σ_T centre is non-luminescent. Denoting by N_T the total number of quanta emitted at temperature T, and by N_0 the same at a low temperature, where $\sigma_T \ll \sigma_0$, the temperature dependence of N_T can be expressed by

$$N_T = N_0 \frac{c_2\sigma_0}{c_2(\sigma_0 + \alpha\sigma_T)}. \qquad (3)$$

Our measurements for the zinc silicate sample examined led to a value $\alpha = 0{\cdot}036$. With the measured values of σ_0 and σ_T we calculated N_T/N_0 and compared it with the measured luminescence.

	T° K.	300	418	518	623	648
$10^6\sigma_T$	obs.	0·022	0·35	2·2	8·3	10·7
N_T/N_0	calc.	0·996	0·94	0·72	0·40	0·34
	obs.	1·00	1·00	0·71	0·42	0·34

The same simple basic connexion was found to be valid for other phosphors too.

We express our thanks here to Prof. Z. Bay, director of the laboratory, for his interest, and to Prof. P. Gombás for suggestions and critical discussions.

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F_2 Ionization and Geomagnetic Latitudes

WHILE studying the relation between the anomalous distribution of F_2 ionization in the ionosphere and the geomagnetic co-ordinates of various observatories, we found that Sir Edward Appleton had already published his results[1] (that issue of *Nature* was not available to us until two months ago owing to post-war difficulties), showing clearly the symmetry of F_2 critical frequencies with respect to the dip angles south and north of the magnetic equator. Later, Prof. S. K. Mitra gave reasons[2] explaining the geomagnetic control of F_2 ionization, and found that the location of maximum critical frequencies obtained from his calculation agrees very well with that shown by Appleton's result. In our work, the critical frequencies are plotted against the geomagnetic latitudes—Figs. 1 and 2 for March and September 1946. Compared with Figs. 3 and 4, where the critical frequencies are plotted against dip angles they show a similar appearance of symmetry. I feel, however, that the dip angles as measured near the surface of the earth, inevitably influenced by local factors, may not represent at all well the geomagnetic effect in a region far above the earth such as the F_2 region in the ionosphere.

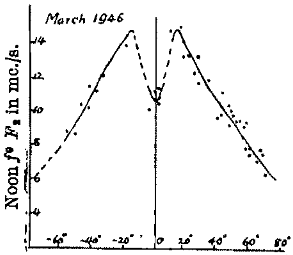


Fig. 1

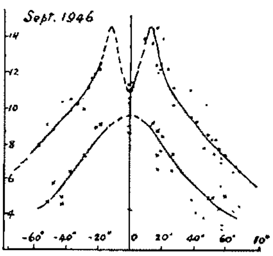


Fig. 2

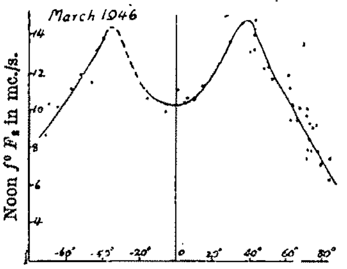


Fig. 3

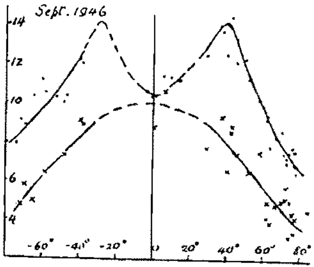


Fig. 4

With reference to the above graphs, the following points are of interest:

(1) The two sets of curves for noon values of $f^0 F_2$, one for March and the other for September, are quite similar. Those plotted with geomagnetic latitudes as abscissæ both show maxima at approximately 14° N. and S.

(2) The curves plotted with dip angles[3] as abscissæ both have maxima around 38° N. and S. These seem to be different from Sir Edward Appleton's figure, in which maxima appear at 28° N. and S., as pointed out by Prof. Mitra in his communication.

(3) Midnight critical frequencies for September 1946 are also plotted in Figs. 2 and 4. There is no drop in value for stations near the magnetic equator. The distribution of points around the smoothed curves are much wider than for noon critical frequencies. However, they still show symmetry with respect to the geomagnetic constants (magnetic latitudes and dip angles) rather than geographic latitudes.

(4) It seems that the drop in ionization near the magnetic equator for the noon curves cannot be entirely attributed to the drift of ions caused by the earth's magnetic field. Since equatorial March or September corresponds to summer in temperate zones, the heating and expansion effect may also account for the drop in ion density. In the equatorial region, noon values are sometimes less than midnight values, as may be seen in the above graphs.

I wish to thank Messrs. S. Wang and W. Chow for their help in the preparation of this letter, and Dr. P. C. T. Kwei for his criticism. The world ionospheric data which have been freely used in this work are supplied by the Central Radio Propagation Laboratory of the National Bureau of Standards, Washington, which subsidizes the Ionosphere Laboratory here in co-operation with the National Wuhan University.

P. H. LIANG

Ionosphere Laboratory,
National Wuhan University,
Wuchang, Hupeh, China.
August 14.

[1] Appleton, E. V., *Nature*, **157**, 691 (1946).

[2] Mitra, S. K., *Nature*, **158**, 668 (1946).

[3] Obtained from Fig. 8, p. 12, "Terrestrial Magnetism and Electricity", edited by J. A. Fleming.

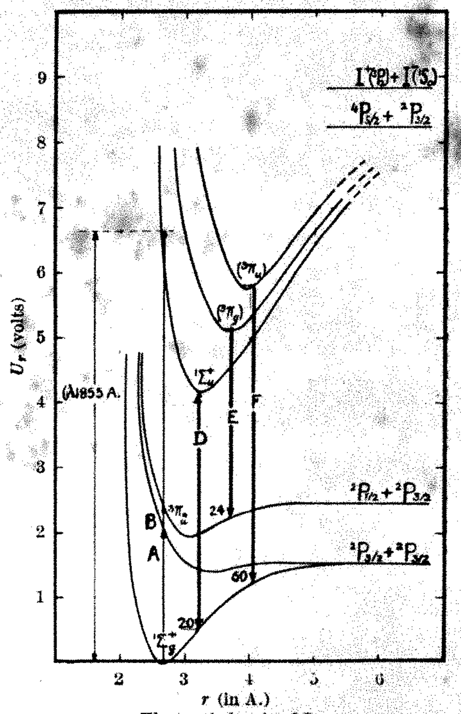
I AGREE with Prof. Liang about the desirability of plotting F_2-layer critical frequencies with magnetic latitude rather than with magnetic dip. In an article in *Science*, p. 17, July 4, 1947, I have given such a plot, which, for noon values of equinox critical frequency, shows two sharp maxima at ± 18° magnetic latitude. The high midnight values of F_2-layer critical frequency at stations on the geomagnetic equator are also attributed to the low electron recombination which is associated with the marked bifurcation of the F-layer into the F_1 and F_2 strata.

E. V. APPLETON

Emission Spectrum of Iodine Molecules in the Presence of an Inert Gas

THE emission spectrum of iodine (I_2) between 5000 and 2500 A. consists of a large number of diffuse bands (McLennan bands) and, especially in the presence of *small* amounts of an inert gas, of some apparently structureless continua[1] at 4800, 4300 and 3420 A. However, as has been shown, particularly by Elliott[2], the spectrum has quite a different appearance if excited in fluorescence by the Al spark lines at 1855–1863 A. in the presence of *large* amounts of nitrogen. The McLennan bands disappear almost entirely, the continua change into well-developed band systems at 4630–4440, 4321–4041(E) and 3450–3040 A.(D), and another well-developed band system appears at 2730–2520 A.(F). From a vibrational analysis of system D, Elliott was able to confirm an earlier interpretation of this system as an electronic transition from an upper state ${}^1\Sigma_u^+$ to the ground state ${}^1\Sigma_g^+$ of I_2 (with vibrational quantum numbers $v'' = 13$–29). He also set up a formula for system F, but his v''-assignment is uncertain, and indeed entirely incorrect according to our analysis. He was unable to interpret the other two systems.

We succeeded in obtaining the emission spectrum of iodine vapour in the presence of several hundred millimetres of argon by a high-frequency discharge. The spectrum was photographed with prism spectrographs of high dispersion and proved to be very similar to the fluorescence spectrum of Elliott. The main differences consist in the absence of the bands (degraded towards the violet) at 4630–4440 A., which, therefore, might belong to the molecule IN, and the appearance of three small continua or band systems at 2880, 2820 and 2770 A. not present in Elliott's fluorescence spectrum (but present in the spectrum excited by active nitrogen[2]). Our present investigation is concerned only with the well-developed band systems F and E. The vibration analysis of these systems strongly suggests the interpretation sketched in the accompanying figure. This assignment of electronic levels is supported by energy considerations based on the fact that the systems considered may be obtained in fluorescence by light of λ 1855 A.



Electronic levels of I_2

The observed band heads, with very few exceptions, are represented, with an average error of about ± 2 cm.$^{-1}$, by the following formulæ :

System F : 2720–2533 A. bands degraded towards the red

$$v = 46440{\cdot}7 + (96{\cdot}21\, v' - 0{\cdot}49\, v'^2) - (213{\cdot}77\, v'' - 0{\cdot}599_5\, v''^2 - 0{\cdot}00367\, v''^3)$$

with $v' = 0$–5, $v'' = 40$–62, intensity maximum at $\sim v', v'' = 3,60$.

System E : 4327–4039 A. bands degraded towards the red

$$v = 25757{\cdot}2 + (101{\cdot}88\, v' - 0{\cdot}34\, v'^2) - (126{\cdot}59\, v'' - 0{\cdot}755\, v''^2 - 0{\cdot}0033\, v''^3)$$

with $v' = 0$–8, $v'' = 13$–32, intensity maximum at $\sim v', v'' = 1,24$.

Our formula for the ground-state of I_2 involved in system F is valid for high values of v'' only (say, $v'' > 30$) and converges, as expected, more strongly than the formula $\nu_{(v'')} = 213{\cdot}76\ v'' - 0{\cdot}596\ v''^2 - 0{\cdot}0021\ v''^3$ given by Loomis[3], following Mecke, for small values of v'' (0–20). The formula used for the lower state of system E is the one given by Loomis for the upper state ${}^3\Pi_0$ ($= 0_u^+$) of the visible bands of I_2. The frequency difference of 5085 cm.$^{-1}$ between the upper electronic states of systems E and F suggests the tentative identification of these states with the terms ${}^3\Pi_g$ and ${}^3\Pi_u$ discussed by Mulliken[4].

All three band systems D, E and F are degraded toward the red and have their intensity maxima near the long wave-length end. This situation usually occurs if the atomic distance r' of the upper state is much larger than the distance r'' of the lower state, that is, if the upper potential curve has ionic character as discussed by Mulliken[4]. These states do not necessarily dissociate into the ions $I^+ + I^-$ but more probably into the lower lying state $I({}^4P_{5/2}) + I({}^2P_{3/2})$. It is of interest that ion-like spectra of this type occur also for the molecules HgX, CdX and ZnX [5], where X = Cl, Br, I.

A more detailed report is to appear in the *Helv. Phys. Acta*.

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July 1.

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[1] A good survey is given by Curtis, W. E., and Evans, S. F., *Proc. Roy. Soc.*, A, **141**, 603 (1933). See also Venkateswarlu, P., *Proc. Ind. Acad. Sci.*, A, **24**, 480 (1946).

[2] Elliott, A., *Proc. Roy. Soc.*, A, **174**, 273 (1940).

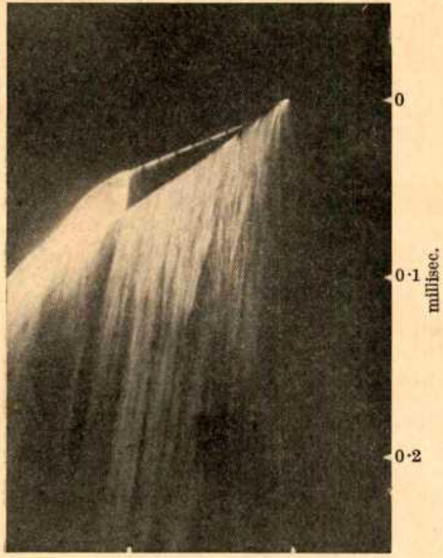
[3] Loomis, F. W., *Phys. Rev.*, **29**, 112 (1927). Mecke, R., *Ann. Phys.*, **71**, 104 (1923).

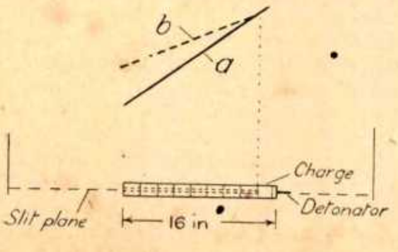
[4] Mulliken, R. S., *Phys. Rev.*, **46**, 549 (1934).

[5] Wieland, K., *Helv. Phys. Acta*, **14**, 420 (1941). See also Victor Henri Memorial Volume (Liège, in the press).

Velocity of Detonation of a Tubular Charge of Explosive

DETERMINATIONS of the velocity of detonation of unconfined columns of pressed tetryl pellets, made by me in these laboratories in 1941 by means of the Buxton rotating-mirror camera[1], showed that the velocity was higher by several hundreds of metres per second when there was a continuous cylindrical cavity in the column. For example, whereas the velocity of detonation in a cylinder of tetryl, 7/8 in. in diameter and of density 1·44, was 6,875 m./sec., the velocity in a cylinder of the same diameter but containing an axial cavity $\frac{1}{4}$ in. in diameter was 7,780 m./sec. Later experiments confirming and extending this result were made here by Dr. W. B. Cybulski with the same camera, after he had introduced modifications which considerably improved its accuracy.





The photographic record reproduced herewith was obtained by Cybulski with a tubular charge formed with pellets of an explosive, translucent when cast (40 : 60-tetryl/trinitrotoluene, density 1·62); the column was 16 in. long, $1\frac{1}{4}$ in. in diameter and contained an open cavity 14 in. long and 0·35 in. in diameter. Initiation was at the closed end. The trace depicted by line *a* of the explanatory diagram is formed by the detonation wave in the wall of the tube, and its slope corresponds with a speed of 7,380 m./sec. (the mean of six determinations having a range of 80 m./sec.). This is 255 m./sec. faster than the velocity of detonation, 7,125 m./sec., in a similar solid cylinder. With a narrower cavity, 0·25 in. in diameter, the speed in the wall rises to 7,410 m./sec., an increase over the normal rate of nearly 300 m./sec. The increase becomes smaller with wider cavities; for example, when the diameter is 0·64 in. the speed in the wall is 7,220 m./sec., an increase of only 95 m./sec. above the normal speed. The trace corresponding with line *b* of the diagram is of a luminous effect within the cavity and visible through the translucent explosive; it moves in advance of the detonation wave in the wall and is no doubt a manifestation of the well-known Munroe effect[2]. Within the cavity the speed is no less than 12,500 m./sec., and beyond the end of the column the effect is recorded as a flame of intense luminosity and long duration; for a short distance its speed is appreciably higher even than within the cavity.

Determinations of the velocity of detonation in cylinders of different diameters show that the value 7,125 m./sec. in this explosive is its limiting velocity, or the 'maximum possible velocity' of Berthelot. It is found that, when the cavity is filled with inert material such as 'Plasticine', the rate in the wall is the same as that in a solid charge; thus a higher value obtained experimentally with a hollow charge is abnormal in that it is a result of events within the cavity. That the passage of the luminous effect therein does not cause a forward motion of the tube, producing only an apparent increase in the velocity of detonation, has been proved by first superposing on the film a shadow photograph of the undetonated charge. At least two other explanations remain: that the passage of the internal effect is responsible either for immediate physico-chemical changes of the explosive in the wall, or for a modification in the form of the detonation wave therein.

The experimental work was carried out for the Ministry of Supply, and thanks are due to the Chief Scientist for permission to publish this note.

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Safety in Mines Research Station,
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June 21.

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[1] Payman, Shepherd and Woodhead, Safety in Mines Research Board Paper, No. 99 (1937).

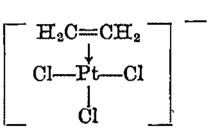
[2] Munroe, *Amer. J. Sci.*, **36**, 48 (1888).

Co-ordination Complexes Containing Olefines

THE concept of the 'co-ordinate link' type of bond formed by donation of lone pair electrons has recently been generalized by Walsh[1] to include also donation by bonding electrons. A similar idea has been independently put forward by Dewar[2] to explain certain intramolecular rearrangements. This new idea that donation by bonding electrons may occur, thus conferring donor properties on the olefinic linkage, is attractive from the purely chemical point of view. In addition to the examples already mentioned by Walsh, additional evidence in support of this concept is to be derived from a consideration of the ability of olefinic compounds to enter into complex formation with metallic salts. This ability has been known since Zeise[3] described the compound $K[PtCl_3.C_2H_4]H_2O$, and it has been found to be widely distributed among the metals, although most strongly exhibited by platinum (*vide* Anderson[4]), in which it has been shown that the ethylenic linkage is functioning as a specific co-ordinating group for platinum. Manchot and Brandt[5] have found that ethylene forms a co-ordinate complex with cuprous chloride analogous to that formed by carbon monoxide; furthermore, Manchot[6] has shown that blood absorbs ethylene, giving rise to a complex similar to, but more easily dissociable than, oxy- and carboxy-hæmoglobin.

In all these co-ordination compounds with metallic salts there is evidence that ethylene plays a part analogous to that of carbon monoxide and ammonia in similar complexes; on chemical grounds there is no intrinsic difference between the co-ordination complexes containing ethylene and those containing either carbon monoxide or ammonia, and they differ merely in their relative degrees of stability. The complexes containing olefines are more easily dissociable, from which it may be inferred that the strength of the olefine → Pt bond is less than that of either the $CO \rightarrow Pt$ or the $H_3N \rightarrow Pt$ bonds. The exact nature of the bond uniting the olefinic molecule to the metallic atom has always remained rather obscure. As pointed out by Anderson (*loc. cit.*), the suggestion that a lone pair may be produced in the olefinic molecule by an electromeric change $R - CH = CH - R' \rightarrow R - \overset{+}{C}H - \overset{-}{C}H - R'$ (that is, derived from an excited state of the olefinic linkage) is unsatisfactory both on chemical and physical grounds.

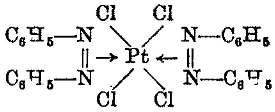
Adopting Walsh's suggestion, however, the mechanism whereby the co-ordinate bond is formed may be readily understood; thus, for example, the structure of the anion of Zeise's salt can be satisfactorily represented by



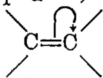
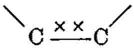
$$\left[\begin{array}{c} H_2C{=}CH_2 \\ \downarrow \\ Cl{-}Pt{-}Cl \\ | \\ Cl \end{array}\right]^-$$

On the basis of the above formulation of these olefinic co-ordination complexes, one might expect that the order of increasing co-ordination ability (as judged by the stability of the olefinic complexes) would run parallel with decrease in π^{-1} ionization potential. However, strict correlation between these two quantities may be counterbalanced by steric factors, which will also play an important part in determining the stability of the complexes. Thus Anderson (*loc. cit.*) has shown, for example, that *cis* configuration greatly promotes co-ordination.

Although in azoxy compounds lone pairs and not bonding electrons are donated, it is possible that in the co-ordination complex, which Kharasch and Ashford[7] have found to be formed between azobenzene and platinic chloride, bonding electrons are donated. The complex may be represented by



in which the azo → Pt bond is a π-electron dative bond, rather than a normal 'co-ordinate link' type of bond formed by the lone pairs on the individual nitrogen atoms.

In view of the general reactivity of the π-electrons in olefinic compounds, as exemplified in the electromeric change , and in donor properties, I would suggest that the conventional double bond formulation might with advantage be rewritten as . Such a formulation would attempt to distinguish between those electrons in the hybridized sp^2, σ bonds and the electrons in a pure $2p_z$ orbital which are responsible for the characteristic reactivity of olefinic compounds.

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[1] Walsh, *J. Chem. Soc.*, 89 (1947).

[2] Dewar, *J. Chem. Soc.*, 406, 777 (1947).

[3] Zeise, *Pogg. Ann.*, 21, 497 (1831).

[4] Anderson, *J. Chem. Soc.*, 971 (1934); 1042 (1936).

[5] Manchot and Brandt, *Ann.*, 370, 286 (1911).

[6] Manchot, *Ann.*, 370, 241 (1911).

[7] Kharasch and Ashford, *J. Amer. Chem. Soc.*, 58, 1733 (1936).

Influence of the Sugar Concentration on the Growth of Isolated Pine Roots

Some preliminary observations are submitted below concerning the culture of isolated roots of a coniferous tree species, *Pinus sylvestris*.

Seeds were collected in the province of Vermland, Sweden (Uddheden, Grasmark, 110 m. above sea-level). To obtain as uniform a rate of germination as possible[1] only the darkest seeds, which were the most numerous, were selected for the experiments. The seeds were disinfected by a 15-min. treatment with a solution of calcium hypochlorite according to Wilson's[2] and Melin's[3] techniques, and were then carefully washed in sterile distilled water. Germination took place at 20° C. on 1·5 per cent washed agar contained in Petri dishes. Root tips approximately 10 mm. long were removed from the seedling roots and transferred to 100 ml. Erlenmeyer flasks (Jena glass) containing 20 ml. of nutrient medium. This medium contained per litre of redistilled water (specific conductance at 18° C. $= 1{\cdot}09 \times 10^{-6}$ reciprocal ohms) the following mineral salts[4]: 50 mgm. $Ca(NO_3)_2$, 10 mgm. $MgSO_4$, 10 mgm. KH_2PO_4, 1 mgm. $FeCl_3$, 0·1 mgm. $Na_2B_4O_7$, 0·1 mgm. $MnCl_2$, and 0·1 mgm. $ZnCl_2$.

As source of carbon and energy use was made of (1) glucose (Pfanstiehl, "C.P. Grade") and (2) sucrose (Schering–Kahlbaum, *puriss.*). The media were supplemented with thiamin (1 γ per 20 ml.), and with biotin (0·001 γ per 20 ml.). The vitamin preparations used were thiamin hydrochloride Merck (Darmstadt) and biotin Merck (Rahway, N.J.).

The culture flasks containing the nutrient solutions were sterilized by autoclaving for 15 min. at a pressure of 1 kgm. per cm.^{2}, corresponding to a temperature of 120° C. The inoculated flasks were incubated at 20° C. for 60 days.

TABLE 1. INFLUENCE OF GLUCOSE CONCENTRATION ON THE GROWTH OF ISOLATED PINE ROOTS

Glucose, per cent	Average total length of 14 roots in mm.	Average number of branches
2	7·8	2·5
3	26·3	3·6
4	46·1	4·2
5	21·6	3·1
6	9·8	2·0

TABLE 2. INFLUENCE OF SUCROSE CONCENTRATION ON THE GROWTH OF ISOLATED PINE ROOTS

Sucrose, per cent	Average total length of 14 roots in mm.	Average number of branches
3·9	14·7	2·5
5·8	79·4	7·4
7·7	28·3	2·9
9·6	6·6	2·3
11·6	0·0	0·0

Some results obtained in assaying the influence of different sugar concentrations on the growth are listed in Tables 1 and 2. In these experiments the nutrient solutions contained 2–6 per cent glucose or of sucrose in a corresponding molarity (3·9–11·6 per cent). The optimum glucose concentration was found to be 4 per cent, while the optimum sucrose concentration was 5·8 per cent, in molarity equivalent to 3 per cent glucose.

Sucrose gave rise to considerably more powerful growth and more branches than glucose, and may hence be a more suitable source of carbon for isolated pine roots than the latter.

The investigation is being continued.

V. SLANKIS

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July 3.

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[1] Kujala, V., *Comm. Inst. Quaest. Forest. Finland.*, **12** (1927).

[2] Wilson, J., *Amer. J. Bot.*, **2**, 420 (1915).

[3] Melin, E., "Abderhalden: Handb. biol. Arbeitsmethoden", Abt. XI, Teil 4, 1,015 (1922).

[4] Robbins, W. J., and White, V. B., *Bot. Gaz.*, **98**, 209 (1936).

Mendelian Inheritance in New Zealand Romney Sheep

THE present purpose is to report further changes in our views on the genetics of *N*-type sheep. As stated and illustrated previously[1,2,3], these animals have very high abundance of halo-hairs in the birth-coat, and their fleeces are usually hairy, that is, have much medullation. Of our four *N*-type stocks, one has been called 'multifactorial-*N*', two are 'dominant-*N*' and one 'recessive-*N*'.

The so-called multifactorial-*N* stock is related to both dominant-*N* stocks, Nielsen-*N* and Massey-*N*. Evidence from experiments not quite complete points to the *N*-gene being the same in both dominant stocks. Breeding tests still in progress make it probable that the 'multifactorial' stock is multifactorial only for modifiers aiding the expression of the dominant-*N* gene. The foundation animals, among the descendants of which selection for *N*-type proved rapidly successful, all had many halo-hairs, but fewer than *N*-type. The original ram, which was horned, and to which the whole stock is traceable, and several of the earliest ewes, were so bred that they could be heterozygous for the dominant-*N* gene. By this time we are familiar with the fact that the dominant-*N* gene may come to poor or even very poor expression in heterozygotes. Finding ourselves thus without any stock that can be regarded as multifactorial in the sense that no one gene plays a major part, we are the more anxious that the genetics of the coats of the hairy mountain sheep of the northern hemisphere should be studied.

Our central problem is the relation between dominant-*N* and recessive-*N*. For four years the hypothesis under test has been that dominant-*N* was a duplication of recessive-*N*. The two genes would then be allelomorphic. *N*-type sheep have been secured from the mating of recessive-*N* and dominant-*N*. Two such recessive-dominant *N*-type rams have been mated with recessive-*N* ewes. The lambs are 20 *N*-type; 7 non-*N*. Four of the non-*N* lambs are by one ram, three by the other. This is the 3 : 1 ratio expected if the genes are independent. The hypothesis is therefore no longer tenable. We are the more anxious to announce this result because reference has been made to this hypothesis by Prof. Ruggles Gates[4,5]. Sheep-breeding experiments take a long time, and it is therefore our policy to pass ideas to fellow-workers in a manner which would be thinking aloud too much if mice were our material.

Recently, we enjoyed the privilege of discussing this work with Prof. Richard Goldschmidt during his visit to New Zealand. He pointed out how often the same character in *Drosophila* is conditioned by different genes, and told us that the simplest interpretation is complete independence of the dominant-*N* and recessive-*N* genes. There is, however, evidence from breeding results, the critical discussion of which would take too much space, which allows us still to wonder whether the two genes, though resident on different chromosomes, may indeed be the same. It is suggestive, too, that in both dominant-*N* and recessive-*N* sheep the same pleiotropic effects occur. The problem is being tackled by further breeding, and one of us (A. S. F.), whose earlier research has been in plant cytogenetics, is studying the chromosomes of rams of different genotypes.

The fact that the two genes are carried by different chromosomes gives greater scope for the study of dosage effects. Horns in ewes, for example, are the rule in homozygous dominants; small horns are frequent in recessive-dominant ewes; horns occur occasionally in heterozygous dominants; and they have not yet been recorded in recessive-*N* ewes. Other characters are being studied in the series of genotypes, notably the abundance of the several fibre types of the birth-coat.

Our attention has recently been directed to the possible application of this fundamental work. In the early days of this College, research was started on hairiness because it was regarded as a wool fault. Then the emphasis came to be put on the genetics of *N*-type. Early in 1946, Prof. A. F. Barker visited New Zealand and spent several days at this College. He urged the breeding of *N*-type sheep on a larger scale in order to supply one of the world's best carpet wools.

F. W. DRY
A. STEWART FRASER
G. M. WRIGHT

Massey Agricultural College,
Palmerston North,
New Zealand.
June 9.

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[1] *Nature*, **145**, 390 (1940).

[2] *Nature*, **148**, 563 (1941).

[3] *Nature*, **154**, 552 (1944).

[4] *Amer. Nat.*, **80**, 76 (1946).

[5] "Human Genetics", 17 (New York, 1946).

'Foveal Tritanopia'

IN his book on colour vision, Dr. W. D. Wright[1] discusses blue-blindness of the retinal fovea, which was described by A. Koenig[2] fifty years ago and is now maintained by Willmer[3] and himself for the same reasons: "This effect does not appear to have been the subject of further extensive study and although other workers were aware of Koenig's observation the general attitude appears to have been one of scepticism. Indeed most people either ignored or were ignorant of the phenomenon until Willmer recently reawakened interest in the subject." Dr. Wright has apparently overlooked the controversy between E. Hering and A. Koenig.

Koenig's[2] hypothesis that the visual purple and yellow are the photochemical substances for grey and blue sensations, the rods the colour-receptors, and the cones only dioptric means to throw the retinal images on the rods, led him to the assumption that the purple-free fovea were blue-blind. His observations with colour equations seemed to confirm his assumptions, as in the case of Drs. Willmer and Wright.

Hering[4] attacked Koenig's observations and conclusions in a paper noteworthy for its concise reasoning and the sharpness of its criticism. Hering showed that direct foveal observation of small blue test objects demonstrates the perfect blue-sensation of the fovea, provided that some precautionary measures are taken which he prescribed with exactness, and that the fovea is the most colour-sensitive spot of the retina.

Conclusions from colour equations and colour-matches on such small retinal fields as the fovea led Koenig to the error of foveal blue-blindness. Colour equations are only valid under three conditions: that the test is of sufficient brightness, that the retinal field has a minimum size, and that the eye is not tired. Hering had shown already in an older paper[5], before Koenig's publication, that the validity of colour equations is limited and that the latter are not valid on very large fields or very small retinal fields such as the fovea. Colour equations with blue-green mixtures need much more blue on small retinal fields such as the fovea (1893). Koenig's short reply[6] was not convincing at all; a more detailed one was promised but never published—a later paper of pathological blue-blindness due to ablatio retinæ and retinitis has nothing to do with the problem in question. Hering[7] replied and again refuted concisely foveal blue-blindness and Koenig's strange theory of the function of rods and cones, just at the time of the making of the duplicity theory. Everyone of that time interested in the subject knew of Koenig's publication and his lecture at the Academy of Sciences in Berlin, and also of the controversy with Hering. There is little doubt that authorities of those days such as v. Kries, Lord Rayleigh and Nagel put such an important question to the test, as was easily done from Hering's description.

Many years after Koenig's death, Sir John Parsons[8] rejected strongly foveal tritanopia in his standard work on colour vision, saying, "This observation (i.e., Koenig's) is certainly untrue". Curiously, he did not cite Hering on this question, although he quotes him otherwise more than sixty times in his excellent book.

Recently, Prof. H. Hartridge[9] has rejected foveal tritanopia for precisely the same reasons as E. Hering in the old days, showing in detail that colour equations are not valid on retinal fields so small as the fovea, and direct foveal observation of blue tests gives clear blue response. But there is again no reference to the work of Hering or Helmholtz[10]; the latter was aware of these facts even before Hering. These facts are not at all recent advances, but apparently they have been forgotten nowadays.

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1 Gascoyne Road,
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[1] Wright, W. D., "Researches on Normal and Defective Colour-Vision" (1946).

[2] Koenig, A., "Ges. Wissenschaftl. Abhdlg.", 338 (1903).

[3] Willmer, E. N., *Nature*, 158, 774 (1944). Willmer, E. N., and Wright, W. D., *Nature*, 156, 119 (1945).

[4] Hering, E., *Pflueger's Archiv.*, 59, 403 (1895).

[5] Hering, E., *Pflueger's Archiv.*, 54 (1893).

[6] Koenig, A., *Pflueger's Archiv.*, 60 (1895); "Ges. Wissenschaftl. Abhdlg.", chapter 25 (1903).

[7] Hering, E., *Pflueger's Archiv.*, 61 (1895).

[8] Parsons, J. H., "Introduction to Colour Vision", 81 (1915 and 1924).

[9] Hartridge, H., *Nature*, 155, 391 and 657 (1945).

[10] Helmholtz, "Physiol. Optik" (2nd edit., 1896), 374.

ALL workers on colour vision will, I am sure, welcome Dr. Karplus' letter, especially for the historical notes on the dispute between Koenig and Hering. It is quite evident from this that the dichromatism of the central fovea, when reported by Koenig fifty years ago, was the subject of some heated discussion; at the same time, when Willmer[1] re-discovered the effect in 1944, it is probably true to say that most workers in the subject had either ignored or were ignorant of both Koenig's results and Hering's discussion of them, and I would have to admit to being among that number. No doubt there were exceptions, and Dr. Karplus is certainly one honourable example; but then I understand that he had the great privilege of working under Koenig in his laboratory—a privilege that may well be unique among those alive to-day.

With regard to the phenomenon itself, I think it should be made clear that the recent observations by Willmer[2], Thomson[3] and myself completely substantiate Koenig's original colour-matching experiments. I suspect that many of the difficulties and differences of opinion that have arisen in explaining the dichromatism have had their origin in the different connotations applied to the word 'dichromatism' and also to the misuse of the word 'blind'. As generally understood at the present time, dichromatism implies that colour matching can be carried out by the mixture of only two matching stimuli, and it is in this sense that the central fovea has been described as dichromatic, and not in the sense of there being only two qualities of sensation associated with its stimulation. The misuse of the word 'blind' is quite extensive in the frequent description of persons with defective colour vision as being 'colour-blind', although the great majority are in no sense blind to any of the radiations in the visible spectrum, since their essential defect is a reduced ability to discriminate the colour quality of one wave-length from that of another. In the same way, it is incorrect to refer to tritanopia as 'blue-blindness'. The radiations at the short-wave end of the spectrum may be perfectly visible and may even give rise to the sensation of blueness, yet at the same time a tritanope or a tritanopic area of the retina will have a reduced ability to discriminate colours in the blue-green region of the spectrum. It is true that observations by Thomson and myself[3], and other measurements reported by Dr. W. S. Stiles at Cambridge last July during the International Colour Vision Conference, show that some loss of blue sensitivity may occur in the central fovea, but we have not suggested that the fovea is blind to these radiations.

Koenig's interpretation of the dichromatism was no doubt in error. It is, however, important not to condemn the experiments along with the theory, and I have no doubt at all about the fundamental soundness of Koenig's original observation of foveal tritanopia, nor of Willmer's re-discovery of the phenomenon.

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London, S.W.7.

[1] Willmer, E. N., *Nature*, 153, 774 (1944).

[2] Willmer, E. N., and Wright, W. D., *Nature*, 156, 119 (1945).

[3] Thomson, L. C., and Wright, W. D., *J. Physiol.*, 105, 316 (1947).

Visual Cells of the Guinea Pig

The statement of Granit[1] that the guinea pig has a "pure rod eye" calls for comment. Franz[2], referring to a paper of his own published in 1909, says that cones are missing from the retina of the guinea pig. Ovio[3] admits the presence of a few cones. Kolmer[4] describes cones and rods. He makes the significant remark that observation prior to his own had been made on poorly fixed material. Rods are four to five times as numerous as cones, and he comments on the clear vacuoles at the peripheral end of the cone myoids.

Preparations of my own made nearly ten years ago confirm the findings of Kolmer. Neither the cornea nor the lens is as large as one would expect in an eye populated only by rods. The ratio of nuclei in the outer layer to that of the bipolars is four, or at the most five, to three (excluding the nuclei of Müller's fibres), a much lower ratio than one expects in a pure rod retina. In the dog it is twelve to four at least, and in a jerboa mouse (*Notomys cervinus* Gould) sixteen to five. These ratios are only approximate, but are an indication of the amount of summation of impulses in the retinæ of these two eyes rich in rods. The eye of the dog is larger than that of the guinea pig, that of the Jerboa mouse smaller. Cup-shaped vesicular areas in the outer molecular layer of the guinea pig's retina suggest that some of the visual cells have dendritic foot-pieces. In my own preparations the cone myoids project beyond those of the rods. The tip of the distal segment of the cone is enveloped in a process of the pigment epithelium, and in areas where the visual cells have lost touch with the pigment epithelium, the cones do not part company with it as easily as do the rods. This enveloping of the tip of the cone has been commented on in the human retina by Walls[5] and Kolmer[6].

To the histologist, the retina of the guinea pig is certainly not 'pure rod'.

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Melbourne.
July 8.

[1] Granit, R., *J. Physiol.*, 103, 103 (1944).

[2] Franz, V., "Vergleichende Anatomie des Wirbeltierauges", in "Handbuch der Vergleichende Anatomie der Wirbeltiere", 2, pt. 2, 1,238. (Vienna: Bolk/Goppert/Kallius/Lubosch, 1934.)

[3] Ovio, J., "Anatomie et physiologie de l'œil dans la série animale", 130 (Paris, 1927).

[4] Kolmer, W., "Vergleichende Anatomie der Netzhaut", in "Handbuch der Mikroskopischen Anatomie des Menschen", 3, pt. 2, 321–326 (Fig. 259), 420–21 (Berlin, 1936).

[5] Walls, G. L., *Arch. Ophthal.*, 12, 1918 (1934).

[6] Kolmer, W., *ibid.*, 318 (Fig. 251 *A*).

Sound Emitted by Dolphins

During a cruise in the Mediterranean last year on board the Swedish research ship the *Skagerak*, I happened to notice that the dolphins (*Delphinus delphis*) uttered sounds that were quite audible on board the ship, though the dolphins were swimming one or two metres below the surface. The sounds may be described as short, rapidly repeated squeaks rather like those produced by fighting or playing mice. As I had many opportunities of listening to the sounds, sometimes with the ship at rest in calm weather, and had several other persons verify the observation, there can be no doubt as to the ability of the dolphins to produce audible sounds.

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Elemental Nomenclature

It may be presumptuous for a zoologist to speak to a chemical question. However, the points raised by Vallarta and Arnaiz y Freg and by Webb in *Nature* of August 12, pp. 163–64, are on all fours with problems of nomenclature familiar to biologists. Del Rio's erythronium was validly published and, from a zoological point of view, his subsequent disavowal was an ineffective act. The chemists are well advised in being cautious about the unreasoning application of the rule of priority. Since the number of elements seems unlikely to be much in excess of a hundred, the problem is quite simple compared with the handling of some 200,000 generic names of animals. Hence the homonymy between two uses of plutonium causes no confusion. Perhaps a new rule might read that if a name has had no employment for fifty years, whether or not withdrawn by its author, it shall become a *nomen vacuum*, with the recommendation that such names should not be re-used with a new meaning. Finally, this rule or any other nomenclatorial rule should not be applied retroactively, since there is an implied contract between the rules and the public that a change in the rules shall not render a previously legal usage illegal. The lawyer calls this *stare decisis*.

Charles H. Blake

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Cambridge, Massachusetts. Sept. 2.

"Miracles"

In my recent review of Mr. C. S. Lewis' book on "Miracles", I wrote that what are described as miracles "occur most freely in periods when critical skill is least". From Mr. E. V. Burke, writing from 27 The Crescent, London, S.W.13, I have received references to the following books on cures recorded at Lourdes: E. le Bac, "Medical Proof of the Miraculous, a Clinical Study" (1922), and G. Bertrin, "Lourdes, its Apparitions and Cures" (English translation by Lady Gibbs), and the *Catholic Medical Guardian*, 1933–34 (case of Pierre de Rudder, broken leg cured instantaneously), which may not be generally known.

I have only to add that I did not say that such cures do not occur when (or where) critical skill is adequate; and Mr. Burke himself writes that "many claimants to miracles are completely rejected" at Lourdes.

John L. Myres

Oxford.

PUBLICATION AND CLASSIFICATION OF SCIENTIFIC KNOWLEDGE

THE direct importance to the research worker of an efficient scientific information service led the Cambridge Branch of the Association of Scientific Workers to hold a conference on October 25 to discuss various schemes that have been proposed. Although the subject had been discussed previously by professional abstractors and librarians, this was the first conference of 'users' of scientific information.

The chairman, Sir Lawrence Bragg, outlined the two main aspects of the problem: (*a*) how are scientific workers to get to know of the work that interests them, and (*b*) having learned of it, how can they get a copy of the actual publication. The first is by far the more difficult. As regards the second, the personal contact provided by correspondence is invaluable, and any centralizing scheme must avoid destroying this.

Prof. J. D. Bernal divided scientific information into 'operative units' according to their length and function (see table). Thus the scientific 'paper' is the operative unit, not the journal. Abstracts should be of two kinds, 'indicative' and 'informative'. The former merely guides you to the paper while the latter should be full enough to be adequate for 'background' reading. By the term 'thesis', he means the fullest possible account of a piece of research, not necessarily a dissertation for a doctorate. He proposed a single subscription to a national distributing agency which would entitle one to receive automatically, say, 1,000 papers a year plus abstracts of a given field or fields. Further papers or theses could be obtained on request.

	BOOKS > 50,000 words	PAMPHLETS 10,000–500,000 words	PAPERS 5,000–100,000 words	LETTERS OR NOTES 100–5,000 words	ABSTRACTS OR TITLES < 100 words
EPHEMERAL		§ Research programmes	Lectures	Letter on work in progress	Title of research project
OPERATIVE		† Theses (full experimental detail and mathematical argument)	*† The scientific paper	*† Note or informative abstract	* Indicative abstract
COLLECTIVE		Monographs	*§ Report (e.g., annual) on progress of a subject	Book reviews and critical articles	§ Bibliographies
DEFINITE	Treatises		§ Handbooks	§ Data tables (fauna – flora, maps, etc.)	§ General indexes
UTILITARIAN	Text-books. Popular science books	Practical monographs	Technical articles	Technical notes	

Note.—The four essential units are outlined with heavier rules.

* To be received automatically. † To be received on request through agency. § Central responsibility for preparation.

Those present at the conference agreed generally with this scheme, provided that the scientific journals continued also to be available in bound series in libraries. Prof. R. S. Hutton pointed out the present and future financial difficulties of the societies in publishing their journals, and suggested that a proper financial arrangement with such a national distributing agency might be decisive in obtaining their agreement to the scheme. Mr. J. W. S. Pringle emphasized that editorial responsibility must rest with the societies, and that it is really a question of the suggested agency buying the copyright and a large number of reprints. Dr. E. Orowan and Prof. Hutton quoted a number of societies, mainly in the metallurgical and engineering fields, which are, in fact, partially operating the proposed scheme, as they treat the paper as the unit and later assemble them into *Transactions*.

Whether reprinting is the most economical method of reproduction was doubted by Mrs. Lucia Moholy, and she gave figures to support the use of micro-filming, particularly when the demand could not be forecast. Dr. D. P. Riley praised the microfilm service run in conjunction with abstracts published by the Centre National de la Recherche Scientifique in Paris, and said that the French Thomson-Houston microfilm-viewer is very good. In discussion, the need for an efficient and cheap British microfilm-viewer (costing about £30) was underlined.

The different needs of the biological and physical sciences were referred to by several speakers. The abstracting service of the Imperial Bureau of Plant Breeding and Genetics was described by Mr. R. H. Richens, while Prof. H. Jeffreys dealt with the position in astronomy, meteorology and geophysics. It was agreed that abstracting should always be done in one of the common European languages. Some interesting suggestions were made with reference to the classification and indexing of scientific papers, and the need for a fundamental theory of classification was made obvious. Most speakers favoured, as an immediate measure, the extension of the Universal Decimal Classification to meet the requirements of new branches of science such as nuclear physics. Mr. J. B. Hasted suggested that the cross-referencing difficulty might be overcome by using a matrix system. Dr. S. Lilley objected to the use of the decimal system, as classification on a binary scale is much more efficient and flexible. The logic of classification is better on a dual system and is ideal for use with machines. His own simple knitting-needle and punched-card system gives the possibility of 10^{33} classes on one card.

An editor's opinion was given by Dr. R. C. Evans. He compared American and British practice; he is convinced that many of the reasons for delays in publication lie in the form in which papers are submitted. The increased speed of communications should logically lead to the creation of international journals such as the old *Zeitschrift für Kristallographie* and the new *Acta Crystallographica.*

Some indication of the need for rationalization was provided by figures given by Prof. Hutton. The number of worthwhile scientific periodicals is 15,000, and the number of original papers in these journals is about 750,000 per year. Of these, 1 in 3 are abstracted; but it should be noted that chemistry accounts for a great number as it is the most thoroughly abstracted branch of science.

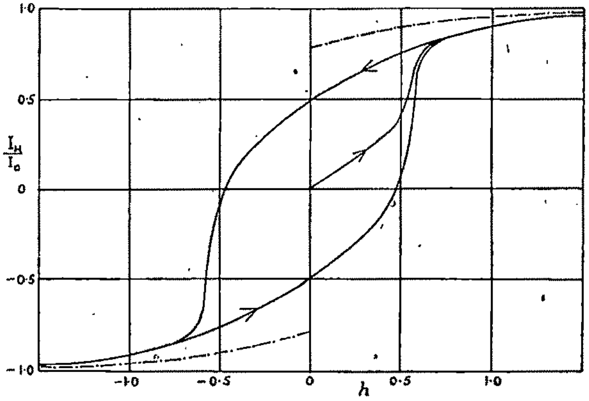
INTERPRETATION OF HIGH COERCIVITY IN FERROMAGNETIC MATERIALS

By PROF. E. C. STONER, F.R.S.,
AND
E. P. WOHLFARTH
Physics Department, University of Leeds

IN the generally accepted theory of the ordinary magnetization curves of ferromagnetics, due to Becker, Kersten and many others, and fully described by Becker and Döring[1], coercivity is related to the amplitude of internal stress variations through their effect on domain boundary movement. Although there can be little doubt as to the correctness of the basic ideas, or to their wide applicability, the treatment cannot account for coercivities of 500 oersted, and more, which are obtained in modern permanent magnet materials, without arbitrary and improbable assumptions about the magnitude and character of the internal stress variations. It occurred to one of us some years ago that for those alloys of the dispersion-hardening type for which the higher coercivities are found, an entirely different type of explanation might be possible, and some preliminary calculations gave promising results. This line of inquiry was interrupted by the War, and no more than vague references to it have been published[2], though it has been discussed verbally and in correspondence with others interested. A systematic attack on the problem was resumed at the beginning of 1946, and a full account of the work has now been prepared. In view of the inevitable delays in publication a brief account may be appropriate here. It may be stated quite frankly that the immediate stimulus to this communication has been two short and admirable papers by Néel[3], which have just appeared, and which show that he has been thinking along similar lines with particular reference to powder magnets.

The central idea is that in many ferromagnetic materials there may occur 'particles' (this term including both actual powder grains and atomic segregates or 'islands' in alloys), distinct in magnetic character from the general matrix, and less than the critical size, depending on shape, for which domain boundary formation is energetically possible. For particles in the form of ellipsoids of revolution, a reasonably precise expression for the lower limit to this critical size is obtained, involving the saturation intensity, I_0, and the Curie temperature of the material of the particle and the smaller demagnetization factor. For spherical particles, the lower limit to the critical diameter is found to be $0{\cdot}8 \times 10^{-6}$ for iron, and $3{\cdot}1 \times 10^{-6}$ for nickel, the number of atoms in the volume being about $1{\cdot}5 \times 10^{6}$ and $1{\cdot}2 \times 10^{7}$ respectively. For prolate spheroids of dimensional ratio 10, the diameters are some four times as great, and the number of atoms $1{\cdot}1 \times 10^{9}$ and $8{\cdot}1 \times 10^{10}$. In such single-domain particles, change of magnetization can take place only by rotation of the magnetization vector, I_0, which remains constant in magnitude and uni-directional throughout the particle. As the field changes continuously, the resolved magnetization in the field direction may change discontinuously at critical values of the field. The character of the magnetization curve depends on the degree of magnetic anisotropy of the particle, and on the orientation of the 'easy axes' with respect to the field. The magnetic anisotropy may be due to anisotropy of shape (the energy depending on direction owing to the directional dependence of the demagnetizing field), magnetocrystalline anisotropy or strain anisotropy.

A detailed quantitative treatment has been developed of the effect of shape anisotropy when the particles are in the form of ellipsoids of revolution, and a less detailed treatment for the general ellipsoidal form, of which the prolate and oblate spheroid are limiting cases. In dealing with ellipsoids of revolution it is convenient to use a non-dimensional parameter h, defined by $h = H/|(N_a - N_b)|I_0$, where N_a and N_b are the demagnetization coefficients along the polar and equatorial axes. The variation with h of the ratio I_H/I_0, where I_H is the resolved value of I_0 in the positive field direction, has been determined, by accurate numerical solution of the equilibrium equations, for a series of angles, θ, ranging from 0° to 90°, of the orientation of the polar axis with respect to the field, and also for random orientation. The magnetization curves for random orientation are shown in the accompanying figure, where the full curves refer to prolate spheroids, the broken curves to oblate spheroids.



For the special limiting case of the oblate spheroid, there is no hysteresis (this applies to all orientations), though there is a discontinuous change in the magnetization as the field passes through zero. For the prolate spheroid, exact expressions are obtained for the critical field, h_0, at which the discontinuous change occurs, and for various related quantities, as functions of the orientation angle, θ. As θ varies from 0° to 90°, the cyclic magnetization curves change from a rectangular form, with $|h_0| = 1$, to a linear non-hysteretic form, with an interesting sequence of intermediate forms. The lowest value of $|h_0|$ is $\frac{1}{2}$, occurring for $\theta = 45°$.

All the numerical results are applicable when the anisotropy is due to longitudinal stress, when h and H

are related by $h = HI_0/3\lambda\sigma$, where λ is the saturation magnetostriction coefficient, and σ is the stress. If λ and σ are of the same sign (as for nickel under compression and approximately for iron under tension) the behaviour is similar to that of prolate spheroids; when the signs are opposite, to that of oblate spheroids. The results also apply to magnetocrystalline anisotropy in the important and representative case in which there is a unique easy axis of magnetization, as for hexagonal cobalt; in this case, h and H are related by $h = HI_0/2K$, where K is the magnetocrystalline anisotropy coefficient.

In general, all three types of anisotropy may be present, and an estimate of the relative magnitudes of the effects is important. For magneto-strain anisotropy, assuming as a reasonable upper limit of the stress, σ, a value of 200 kgm.mm.$^{-2}$, the maximum values of H/h for iron, nickel and cobalt are about 600, 4,000, and 600 respectively. For the magnetocrystalline effect, H/h is about 6,000 for cobalt; for cubic crystals, the numerical results obtained do not apply in detail, but the maximum coercivity may readily be estimated as about 400 for iron, and 200 for nickel. For shape anisotropy, H/h has a maximum value (for elongated particles) of $2\pi I_0$, giving about 10,800 for iron, 3,200 for nickel and 8,900 for cobalt; even for a dimensional ratio as low as 1·1, the values are 810, 240 and 670 respectively.

Although the mechanism outlined, involving magnetically anisotropic single-domain particles, may be involved to some extent in a wide range of ferromagnetic materials, there are three types of materials in which it is likely to be of predominant importance. These are (1) powder magnets, (2) non-ferromagnetic metals and alloys containing ferromagnetic 'impurities'[4], and (3) high coercivity alloys[5] of the dispersion-hardening type. Néel's papers are concerned particularly with powder magnets, which have been greatly developed in France in recent years, and about which little information was accessible to us. A survey of the literature on (2) and (3) leaves little doubt that the 'single-domain particle' mechanism provides in many cases a more satisfactory interpretation of the observed magnetic characteristics than any other that has so far been suggested. As the coercivities are often in the region of 500, it is usually not possible from the evidence available to draw definite conclusions as to the type of magnetic anisotropy primarily involved, though with coercivities appreciably greater than this, and with 'iron-like' segregates, there is strong presumptive evidence of some degree of shape anisotropy. For alloys of the alcomax or ticonal type, for which the remarkable effect of cooling in a magnetic field is well known, but not satisfactorily explained, it is significant that the demagnetization curves along and perpendicular to the direction of this field are strikingly similar to those for single-domain particles with a unique easy axis of magnetization aligned at nearly 0° and nearly 90° to the applied field. This suggests that cooling in a field favours a preferential growth of single-domain segregates with easy axis along or near the field direction.

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[1] Becker, R., and Döring, W., "Ferromagnetismus" (Springer, Berlin, 1939). (Photo-lithoprint reproduction, Edwards Bros., Ann Arbor, Michigan, 1943.) See also Kersten, M., *Phys. Z.*, **44**, 63 (1943).

[2] Stoner, E. C., *Proc. Phys. Soc.*, **52**, 175 (1940); *J. Inst. Elec. Eng.*, **91**, 340 (1944); *Phil. Mag.*, **36**, 803 (1945).

[3] Néel, L., *C.R. Acad. Sci. Paris*, **224**, 1488 and 1550 (1947).

[4] For a review, see Constant, F. W., *Rev. Mod. Phys.*, **17**, 81 (1945).

[5] For a review, see Hoselitz, K., *J. Sci. Instr.*, **23**, 65 (1946).

THE MELLON INSTITUTE

ANNUAL REPORT FOR 1946–47

REVIEWING the post-war plans of the Mellon Institute of Industrial Research in the thirty-fourth annual report, the director, Dr. E. R. Weidlein, refers to the loss by the Institute since 1942 of many able scientific workers and to the difficulty, in view of the general shortage of scientific man-power, of acquiring the staff required for expansion. It is a part of the Institute's responsibility to foster the training of research workers, however, and of 609 'fellows' who left the Institute during 1913–46, forty per cent took up appointments with the donors of their fellowships and 6·7 per cent with other donors. The average term of service of these fellows was four and a half years, as compared with an average of 7·2 years for fellows now in the Institute. During 1946–47, the Institute had 295 fellows in applied science with a further nine in the department of research in pure chemistry and five in that of research in chemical physics, together with a total of 283 associates, assistants and laboratory technicians. Eighty industrial fellowships were in operation during the year, of which fifty were multiple fellowships. Six fellowships had been proceeding for thirty years or more, two for at least twenty-five years, nine for fifteen years and nineteen for at least ten years.

The Department of Research in Pure Chemistry continued to focus attention on synthetic organic chemistry as applied to biological and chemotherapeutic problems, and in a study of the nitrophenyllepidylcarbinols, good yields of the *m*- and *p*-nitrobenzylidenedilepidine compounds have been obtained. A series of substituted 4-amino-6-β-hydroxyethoxyquinolines was prepared, as well as some quinoline azomethines and their hydrogenation products. The comparative properties of 2- and 4-mercapto-7-methylquinoline have been investigated, and the study of specialized uses of hydroxyethylapocupreine and related derivatives in chemotherapy has been resumed and extended. Research has been advanced on the reactivity of esters of *p*-toluene sulphonic acid towards sodium iodide dissolved in acetone. Investigation of the kinetics of the reaction of substituted ethyl benzene sulphonates with sodium ethoxide in ethyl alcohol indicates that the reaction is of the second order, and some attention has been given to the synthesis of the substituted benzene sulphonyl chlorides. Use of cyclic alkylene carbonates and sulphites for hydroxyalkylation of phenols, amines and mercaptans has been extended to esters of 1 : 2- and 1 : 3-glycols. The chemistry of pyrimidine derivatives, correlated with heterocyclic structures of biological importance, is also under investigation.

The Department of Research in Chemical Physics has completed a precise re-determination of the lattice constant of lead, and with the nickel fellowship has contributed a joint paper on X-ray diffraction of nickel–aluminium alloys. The quantitative analysis of crystalline mixtures by means of the Geiger-counter spectrometer, the determination of molecular structure through the analysis of infra-red and Raman vibration spectra and the design of absorption cells, instruments and techniques for Raman, infra-red and ultra-violet investigations of pure hydrocarbons in the liquid phase and under pressure are also receiving attention.

Ceramic investigations have included the utilization of bentonite in compounding plastics as an extender rather than as an inert filler, and one such type of compression-moulding plastic has reached pilot-plant production. A recent fellowship on white cover-coats of high titania content has been successfully directed towards better colour values, ease of application and lighter application weights. In the metallurgical field, studies of the effect of heat treatment on the physical properties of iron powders have led to the establishment of specific processing methods, and encouraging results have been obtained in the use of specially processed silicon carbide, 'Ferrocarbo', in steel making and cast-iron founding. A multiple fellowship of the Scaife Co. has led to a better understanding of the strain patterns with variation in design of pressure vessels, especially the strain concentrations in the walls at service and testing pressure, and arc welding is being investigated as a more economical method of fabricating thin-walled pressure vessels. In a multiple fellowship on the utility of silica gel – supported catalysts for promoting hydrocarbon reactions, fairly definite conclusions have been reached for one type of catalyst on the relations between silica support and the activating materials conducive to activity. Research on gas by-products, in addition to providing the basis for the manufacture of polystyrene at Koluta, Pennsylvania, has led to methods for the removal of hydrogen sulphide in low concentrations from gas rich in carbon dioxide and for the production of ammonium sulphide from hydrogen sulphide from coal gas by the Koppers sodium carbonate hot-vacuum process. The phase relations of maleic anhydride, with particular reference to its recovery from the oxidation products of benzene, the properties of plasticized pitches, particularly rheological properties over wide extremes of temperature, the hydrogenation of anthracene cake and the oxidation of cyclohexane and ethylcyclohexane in the liquid phase and of naphthalene and benzene in the vapour phase are other subjects investigated under the fellowships of the Koppers Co., Inc.

In the petroleum field, studies of the chemical correlation of crude oils and bituminous materials have been extended, and new and more precise methods of separation and new correlations of physical properties have permitted better comparisons. The controlled polymerization of selected olefins to specific isomers has been effected, and progress made in determining the constitution of new types of sulphur compounds derived from olefins. A new class of anti-oxidants has been developed, and work with radioactive C^{14} on the mechanism of the Fischer–Tropsch synthesis has been particularly fruitful. Under the Carbide and Carbon Chemicals Corporation's multiple fellowship for organic synthesis, hydraulic brake fluids based on the 'Ucon' lubricants have been developed, and another member of the 'Ucon' family, 'Flexol Plasticizer B-400', relieved the castor oil shortage for the cloth-coating industry. An improved softener and flame-retarding composition for treating decorative paper products was also developed; and in addition to the modification of wool to increase resistance to insect attack and shrinkage, anti-static treatments for synthetic fibres are being investigated.

In the field of food products, a preliminary study has been made of the retention of folic acid in strained foods, and a new absorbent for refining sugar has been developed which can replace bone black without change in refinery practice. Work on zein has led to new dispersion systems for the preparation of coatings, inks and pigment binders; and a new technique for handling zein has yielded solutions promising for back-sizing mastic tapes and for use as undercoats to prevent absorption of nitrocellulose lacquer. Esters of inositol with drying oil fatty acids have excellent colour and cook rapidly to very clear, light, hard varnishes, while alkyds from inositol have possibilities as varnish modifiers and plasticizers for films. A suitable process has been worked out for the analysis and control of mildew-proofing agents for treating military equipment, and investigation of sizing compositions for knitting nylon hosiery yarns as well as fundamental studies of felts and felting processes are also in progress.

A wood-like product has been made from waste wood, comparable to the original wood in nailing and sawing qualities, and is now at the pilot-plant stage. Satisfactory progress has been made with a programme for controlling by instruments the continuous manufacture of *GR-S* rubber from butadiene and styrene, and a new type of chlorinated rubber, characterized by its flexibility and toughness, has been developed. An organic coating system to extend the life of steel condensers and of heat exchanger and boiler tubing has been developed and a new technique for formulating such coatings examined. Both the fundamental chemistry and the practical applications of organo-silicon compounds have continued to receive study, and the silicone fluids, through their low vapour pressure, wide range of fluidity and stability to high temperature, have solved a heating problem where pressure lines for steam or other vapours are impracticable or uneconomic. An insecticidal fellowship of the Rex Research Corporation, under which in the course of thirteen years five hundred new compounds have been prepared and tested, has now led to the use of piperonyl butoxide and piperonyl cyclohexenones on a large scale, while other compounds have shown promise. Petrolatum research has yielded a sterile petrolatum gauze burn-dressing in convenient, individual package form, and a group of hydrophile ointment bases, capable of being sterilized, with definite therapeutic properties. A method for the determination of polyethylene glycols in biological fluids has been developed, and their chronic physiological effect examined. The Industrial Hygiene Foundation has been further strengthened during the year, and a new professional committee on chemistry and toxicology appointed.

ELECTRONS AND THEIR UTILIZATION

DURING the present century, a new 'slave-trade' has arisen. Individuals are torn from their native element and are made to perform functions entirely foreign to them; immense coercion is applied to make them perform these functions; and when they have performed them they are carelessly discarded. Since the existence of these individuals—electrons—was first recognized fifty years ago, man has transformed out of all recognition his power and control over them. We are now not sure of the exact nature of the electron. Is it a particle or a wave packet? But whatever it is, wave-mechanics leads to no suggestion that the electron has a soul;

and so man can, for the present, continue his slave trade without any qualms of conscience.

The exhibition arranged by the North-West Branch of the Institution of Electronics and held at the College of Technology, Manchester, during July 22–23, might justly be described as a tour of the torture chambers of the electrons, the scale of tortures being finely graded from the mere interchange of habitat, as in accumulators, to the dragging out into free space and violent oscillation that occurs in high-frequency valves. In fact, this gradation provides a convenient basis for the classification of the various items that were shown in the exhibition.

The Chloride Electrical Storage Company exhibited many examples of accumulators and an interesting set of illustrations of rather unusual uses. These were happily chosen to cover a wide field—from the upper atmosphere (in *radio-sonde* apparatus) to below sea-level (the detection of fire-damp in mines). And to hint at more drastic electronic exercises, a portable oscilloscope was shown.

The various types of discharge lamps might well form the next subject. In these, electrons are caused to collide with the molecules of a rarified gas, which is thereby ionized; the return to the stable state is manifested by the emission of light, and, so far, this method of producing light is the most economical of power. It has, however, other advantages: it can be made almost instantaneous, by discharging a condenser through the lamp; and it can be used for stroboscopic purposes, by causing the discharge to occur periodically. Siemens showed examples of photographs taken with their 'Sieflash' argon lamp, which can produce an intensity of more than 10^8 lumens in a single flash lasting 10^{-4} sec. Ferranti's showed examples of their neon-filled 'Neostron', which is particularly designed for stroboscopic purposes.

The next stage of complication may well be taken as the radio valve; many examples were shown by Mullard's, Ferranti's, Cossor's and B.T.H. Particularly outstanding were the Mullard water-cooled 20 kW. valve and their valves made of silica, the internal construction of which was shown by sectioned models.

In addition to making electrons oscillate, we can subject them to lateral forces; this leads us to the cathode ray oscillograph—that 'maid-of-all-work' of the modern laboratory. Numerous examples of the utility of this instrument were shown, ranging from the visual observation of the electrical changes that occur in heart-beats (the Cossor electrocardiograph) to the vibration analyser of G.E.C. and Mullard. Many standard models were also shown by various firms, with suggestions for the different ways in which they can be utilized. Of particular interest were the small G.E.C. Miniscope and the Ferranti exhibit showing electron diffraction by an internally mounted specimen of zinc oxide.

Although interest was mainly centred on electrons, some space was also devoted to the means whereby electron convolutions are made possible—that is, the production of high vacua. Metropolitan-Vickers showed models of their pumps and pressure gauges, and a sectional model of a demountable X-ray tube in which these are used. Edwards also showed examples of modern pumps and the various oils used in them. People who use high-vacuum equipment are perhaps apt to take this side of their apparatus for granted, and these two stands should have helped to impress on such people that vacuum production is still a skilled art, and that improvements are continually being introduced in the process.

The range of application of all these devices was illustrated by many examples, and mention of only a few gives some idea of the uses to which electronics can be put in modern industry. There were a potentiometric titration apparatus, a layer-thickness meter for non-magnetic coatings on magnetic bases, a moisture-in-timber meter, controls to provide constant meter speed independent of load, dielectric heating for insulators or poor conductors, spot-welder control for accurate reproduction of welds, and cloth-guiding equipment for use in mills.

In short, one gained the impression that there was nothing that electrons cannot do, given the guiding hand of science behind them, and the exhibition fully served its purpose in directing attention to these powers. But largely it was preaching to the converted, and many looked with envy on the instruments that they could not purchase, or that they could only be promised months or years hence. If exhibitions such as this show us the golden age of the future, they also impress upon us the fact that it has not yet begun, and that a great deal of hard and concentrated work is necessary before we can usher it in.

NO PEARLS IN COCO-NUTS

DR. A. REYNE has recently published a detailed description of work carried out during the War "On the Structure of the Shells and Pearls of *Tridacna squamosa* Lam. and *Hippopus hippopus* (Linn.)" (*Arch. néerl. Zool.*, **8**, 206; 1947). The structures of the pearls and shells were studied by grinding surfaces in different directions, by examination of thin splinters, by slow solution in acids and by X-ray diffraction photographs. The author unfortunately lost his collection during enemy action at Wageningen in 1944 and 1945, so that a thin-section study has still to be made, and in the absence of photographs of some pearls and sections he has supplied text-figures drawn from his notebook sketches.

The structure of the *Tridacna* shell is elaborated in greater detail than in O. B. Bøggild's "The Shell Structure of the Molluscs" (1930), and the author claims to have written the first description of the *Hippopus* shell. X-ray powder photographs of the shell and the pearls of the species described show that the chief inorganic component is aragonite. The orientation of the fibrous crystallites of aragonite revealed by a photograph of a chatoyant pearl has not, however, been studied in detail.

Dr. Reyne was chief of the Coco-nut Research Station at Menado (Celebes) 1930–33 and examined the collection of "Coco-nut pearls" of the late Dr. J. G. F. Riedel, who claimed to have found one in a coco-nut which he opened himself (*Nature*, **115**, 138; 1925). Dr. Reyne concludes that these are all true *Tridacna* pearls and that Riedel had been deceived by some trick of the natives. Even in 1835 Quoy and Gaimard were already of the same opinion, who writing of *Tridacna* said "c'est aussi le lieu de parler de ces perles assez grosses, mais peu régulières, que secrète le manteau, et qui, dans plusiers endroits de l'Inde, aux Moluques et aux Mariannes, passent pour être un produit de la végétation, et se trouver dans l'intérieur de la noix de coco".

FORTHCOMING EVENTS

Monday, November 10

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.15 p.m.—Mr. S. S. Carlisle: "An Experimental Electrical Pressure Meter for Measurement of Furnace Roof Differential Pressures".

Tuesday, November 11

Zoological Society of London (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "The Vegetation of the Chalk", 3. "Colonisation and Succession; The Flora of Arable Chalk Soils; Chalk Scrub Vegetation".

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. T. A. Hall and Dr. G. G. Haselden: "The Purification of Gases in Low Temperature Processes"; Dr. M. Ruhemann: "The Ammonia Absorption Machine".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "What Equipment is Necessary for the Servicing and Testing of Electronic Devices?" (to be opened by Wing Commander P. Allerston).

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 7 p.m.—Mr. J. C. Williamson: "The Metallurgy of Musical Instruments".

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the Gravesend Engineering Society, at the Royal Clarendon Hotel, Gravesend), at 7.30 p.m.—Films and Discussion on "Water Treatment" (organised by Mr. S. Stevens).

Wednesday, November 12

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. R. N. J. Saal: "Rheological Investigation of Asphaltic Bitumen in connexion with its Technical Applications".

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Mr. E. Devons: "Economic Planning".

Thursday, November 13

Physical Society, Acoustics Group (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 4 p.m.—Discussion on "Supersonic Absorption in Liquids" (to be opened by Mr. J. M. M. Pinkerton).

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. A. V. Hill, C.H., F.R.S.: "The Resolution of Physical and Chemical Events in Muscular Contraction"; Mr. R. M. Davies: "A Critical Study of the Hopkinson Pressure Bar".

British Glaciological Society (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5 p.m.—Mr. H. F. P. Herdman: "The Southern Pack Ice".

Chemical Society (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. L. Hunter: "The Hydrogen Bond in Organic Chemistry".

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. E. W. H. Selwyn: "Photographic Resolving Power of Lenses".

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. A. Landolt: "Hydrophobic Melamine Compounds in Textile Processing".

Chemical Society (joint meeting with the Local Sections of the Royal Institute of Chemistry and the Society of Chemical Industry, at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. Philip Eggleton: "Diffusion in Biological Processes".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. Hans Flück: "Chemical and Biological Aspects of the Conservation of Vegetable Drugs".

Textile Institute, Macclesfield, Leek and District Section (joint meeting with the Leek Textile Society, at Nicholson Institute, Leek), at 8 p.m.—Dr. V. G. Jolly: "Abnormal Colour Vision".

Wednesday, November 12—Thursday, November 13

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S.W.1).—Autumn Meeting.

Friday, November 14

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. S. A. Woods: "Colour in Industry with particular reference to Painting Machinery".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Chemical Society (joint meeting with the Southampton University College Chemical Society, in the Physics Department, University College, Southampton), at 5 p.m.—Dr. U. R. Evans: "The Corrosion of Metals".

Institution of Mechanical Engineers, Applied Mechanics Group (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. E. Rose: "The Mechanical Differential Analyser, its Principles, Development and Applications"; Dr. S. C. Redshaw: "An Electrical Potential Analyser".

Plastics Institute (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—"Injection Moulding of New Thermoplastics".

Institute of Economic Engineering (at the Waldorf Hotel, Aldwych, London, W.C.2), at 7 p.m.—Mr. Wilfred B. D. Brown: "A Proposed Code of Human Management".

Institute of Welding, North London Branch (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. D. Hanson: "Training for Industry".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

States Agricultural Advisory Officer—The States Supervisor, States Office, Guernsey (November 15).

Lecturer in Mathematics—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (November 15).

Research Physicist—The Director, Institute for Industrial Research and Standards, 45 St. Stephen's Green, Dublin (November 15).

Lecturer in Chemistry up to B.Sc. standard—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (November 15).

Research Fellowship in Rheumatism—The Registrar, The University, Leeds 2 (November 15).

Senior Assistants (2) in the Department of Mechanical Engineering, Lecturers (3) in Mechanical Engineering (Design), and a Lecturer in Mathematics—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (November 15).

Graduate Lecturer in Chemistry and related subjects at the Blackpool Technical College and School of Art—The Chief Education Officer, 3 Caunce Street, Blackpool (November 15).

Teacher of Mining Subjects at the Openshaw Technical School—The Chief Education Officer, Education Offices, Deansgate, Manchester 3 (November 15).

Instructor in Horticulture at the Farm Institute, Merrist Wood, Worplesdon—The Chief Education Officer, County Hall, Kingston, Surrey (November 15).

Assistant Lecturer in Inorganic and Physical Chemistry—The Registrar, University College, Hull (November 17).

Lecturer or Assistant Lecturer in Zoology—The Registrar, King's College, Strand, London, W.C.2 (November 22).

Assistant Lecturer (temporary) in Botany—The Principal, Royal Holloway College, Englefield Green, Surrey (November 23).

Assistant Experimental Officers (temporary, Ref. G.460/47A), and Experimental Officers (temporary, Ref. G.461/47A), in the Department of Agriculture for Scotland, for Inspection, for Insect Infestation, of foodstuffs, warehouses, shops and various storage and food manufacturing premises and associated laboratory work—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (November 24).

Lecturer in Geography—The Registrar, The University, Manchester 13 (November 28).

Lecturer or Assistant Lecturer with special qualifications either in Economic History or in Applied Economics—The Registrar, University College, Hull (November 29).

Physicist to carry out investigations into the structure and physical properties of cellulosic fibres, and a Laboratory Assistant to the Senior Physicist—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey (November 30).

Experimental Officer, and an Assistant Experimental Officer, for work in London on insecticides—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (November 30).

Senior Lecturer in Biochemistry—The Secretary of University Court, The University, Glasgow (November 30).

Lecturer in Engineering at Peterborough Technical College—The Chief Education Officer, Education Offices, Town Hall, Peterborough (November 30).

Meteorological Officer Cadets (10) in the Department of Industry and Commerce—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 3).

Lecturer in Physics—The Principal, Royal Technical College, Peel Park, Salford 5.

Laboratory Superintendent by the Government of Nigeria for Medical Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18391.

Head of the Engineering Department of the County Technical College, Wednesbury—The Director of Education, Dept. F.E., County Education Offices, Stafford.

Biometrician (Ref. M.N.18186), an Agronomist (Ref. M.N.18175), and a Tobacco Breeding Specialist (Ref. M.N.18181), for the Directorate-General of Agriculture, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No.

Laboratory Steward (temporary, man or woman)—The Principal, Brixton School of Building, Ferndale Road, London, S.W.4.

Laboratory Steward in the Department of Botany, and a Laboratory Steward in the Department of Physiology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

Assistant Technical Secretary (male) by the Ironmaking Division—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Research Assistant in the Pomology Department—The Director, John Innes Horticultural Institution, Merton, London, S.W.19.

Assistant Technician in Chemistry Department—The Secretary, College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

Scientific Assistant for bureau literary work—The Director, Imperial Bureau of Animal Health, New Haw, Weybridge, Surrey.

Lecturer in Mechanical Engineering—The Principal, Erith Technical College, Erith Road, Belvedere, Kent.

NATURE

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CONTROL OF ATOMIC ENERGY

THE second report of the Atomic Energy Commission to the Security Council which was adopted by the Commission on September 11 with only the U.S.S.R. representative voting against it, although the Polish representative abstained, outlines specific proposals dealing with the functions and powers of an international agency for the control of atomic energy. The Commission did not consider that the Soviet Union's proposals of June 11 provided an adequate basis for developing specific proposals for an effective system of international control of atomic energy, and discussions have not led to a reconciliation of the views of the Soviet Union with those of the majority of the Commission on major points of principle. The proposals of this second report are, in fact, based on three principles which were vigorously contested by the representative of the U.S.S.R. These principles are, first, that decisions concerning the production and use of atomic energy should not be left in the hands of nations; secondly, policies concerning the production and use of atomic energy which substantially affect world security should be governed by principles established in the treaty or convention which the agency would be required to carry out; and thirdly, nations must undertake by convention to grant to the agency rights of inspection of any part of their territory, subject to appropriate procedural requirements and limitations.

The proposals of this second report provide for production quotas based on principles and policies specified by convention; ownership by the agency of nuclear fuel and source material; ownership, management and operation by the agency of dangerous facilities; licensing by the agency of non-dangerous facilities to be operated by nations; and inspection by the agency to detect clandestine activities. The specific proposals of this report are believed by the Commission to provide the essential basis for establishing an effective system of control to ensure the use of atomic energy only for peaceful purposes, and to protect States which comply with it against the hazards of violations and evasions. Furthermore, the Commission considers that such questions as the organisation and administration of the agency, the geographical location of dangerous activities and 'stock-piling', prohibitions and enforcements, and the stages of transition to a system of international control, can only be discussed effectively within the framework of conclusions regarding the functions and powers of the international agency.

In arriving at these conclusions, the Commission believes that the establishment of security is the paramount requirement, and the system of control is designed to give the international agency the means of preventing preparation for atomic warfare, as well as to diminish the possibility of one nation or group of nations achieving potential supremacy in the field of atomic energy, to give warning to complying States of any breach of the treaty and to dispel suspicions and false accusations. In choosing between alternative policies, the elimination of national rivalries in the production, distribution and accumulation of nuclear fuels and the determination of overall production-rates are regarded as of outstanding importance to security. At present the science and technique of the production of nuclear fuel are far in advance of its use for peaceful purposes ; nuclear fuels can be produced in quantities which greatly exceed their present possible uses in medicine, research and industry. In stressing this, the report emphasizes that if the right to decide on the number and size of production facilities and on the size of the stocks of source material and nuclear fuel situated on their territory be left to nations, the control measures recommended in the first report of the Commission would not, if applied alone, eliminate the possibility of one nation or group of nations achieving potential, or through seizure, actual, military supremacy.

For this reason the right to take these decisions cannot be left in the hands of individual nations; and accordingly, in this second report, the Commission would charge the international agency with the further duties of implementing the terms of the treaty or convention in respect to the production, distribution and storage of nuclear fuels and the distribution and utilization of dangerous facilities depending on nuclear fuels, as well as supervising mining quotas and the transfer and processing of source material. It is not recommended, however, that the agency should define the policy to be pursued in the production and use of atomic energy. The principles governing this policy should be established by international agreement, and it would be the duty and responsibility of the agency to implement such an agreement. The production of nuclear fuel in a form suitable for ready conversion to weapon use would be kept by the agency at the minimum required for efficient operating procedures necessitated by actual beneficial uses, including research and development. The agency would also be charged with the duty of carrying out the terms of the treaty or convention concerned with the type and location of reactors which fall within the category of dangerous facilities ; and when the technique of the industrial utilization of atomic power has been sufficiently developed, the international agency, within the limit imposed by security, should make that power available on a fair and equitable basis to any nation which may require it.

In regard to research and development, while the agency should have the power to conduct such work, and must have full scientific knowledge of all matters relating to atomic energy, including all innovations as they occur, it is not proposed that private or national research or development work should cease. Such national activities would be limited in scope only in so far as is necessary for reasons of security. Nations or individuals would be forbidden to use nuclear fuel for the manufacture of any atomic weapon, or to use dangerous quantities of nuclear fuel. Since the first report was issued, further study has established the necessity for international control and allocation of the quantities and locations of uranium and thorium which are to be separated, the time and place of the further processing and purification of source materials, and the size, use and disposition of working stocks and stocks in transit. Without such comprehensive international control of the flow of source materials, from the first point where they are capable of being diverted, there would always be a serious risk of the diversion of source material.

The basic policies and provisions governing the exercise of this international control and direction must be specified in the treaty or convention ; ownership of source-material, from the time it is removed from its natural deposit, or from the time other important constituents have been extracted, should be vested in the agency, which would be authorized to lease these materials for authorized uses. The exercise of the right which the international agency must possess, of determining on the spot whether a nation is conducting clandestine preparations for atomic warfare, would be subject to various procedures designed to guarantee nations and individuals against abuse on the part of the agency. These procedures will require consideration from a juridical point of view so that they may be defined in legal terms capable of juridical interpretation.

The rejection by the Soviet Union of the very principles on which these proposals are based, including as they do the prohibition of atomic weapons, makes it difficult to see what further proposals can be advanced with any real hope of unanimous agreement. It is not that there appears to be any ideological obstacle to preclude such agreement : apart from the International Control Commission proposed by the U.S.S.R. last June, so long ago as February 15, 1928, the U.S.S.R. delegation to the League of Nations proposed in a draft Disarmament Convention the adoption of a comprehensive scheme of international inspection. It seems rather that the U.S.S.R. refuses to recognize the logic and inevitability of the conclusions reached by other members of the Commission, and insists on imputing bad faith to all those who do not accept its own views.

Admittedly the atomic bomb put the United States in a powerful position in the military sense, and if competition in atomic weapons should prove unavoidable the United States would have a considerable start which it could almost certainly retain without difficulty. That its desire is otherwise could scarcely be made clearer, and it may well be questioned whether any country could have shown a more striking example of disinterested good faith in the peaceful aspirations of the common man. All atomic energy matters have already been placed by the U.S. Government under civilian control to facilitate the application of atomic energy to peaceful and beneficial purposes. Within its own territory also, all uranium and thorium ores, even those which contain as little as one twentieth of one per cent, have already been placed under the strict control of the American Atomic Energy Commission; and even apart from the threats and accusations of the U.S.S.R., the United States can scarcely be blamed for declining to destroy its stocks of materials before an international authority has been set up with the powers and resources to exercise effective control.

While it may be doubtful whether the U.S.S.R. would accept the point that a convention outlawing the atomic bomb could come into force only when satisfactory controls have been established, the suggestion has not yet been rejected by Mr. Gromyko. Moreover, against the slight gain that the international inspectorate to which the U.S.S.R. has agreed is to be answerable only to the Control Commission, has to be set the unequivocable rejection of the functions of licensing, management and supervision of the dangerous undertakings. Even minor powers of control by the Commission remain subject to the veto in the Security Council, and national acceptance of any recommendations for the carrying out of international rules is to be entirely optional. The questions of secrecy and of the exchange of information are scarcely mentioned in the second report, although their importance is emphasized in the Russian proposals. Without the inclusion of all these safeguards against national misuse of atomic power on which there is widespread agreement outside the U.S.S.R., no form of inspection could be effective.

It is still necessary to continue to explore the possibility of agreement, even though it be with diminishing hopes. The two primary questions that are now emerging, however, are whether at the present time it would not be wiser to postpone consideration of the control of large-scale power production and forgo the use of atomic power until the world is better prepared for it; and whether the development of an atomic energy authority among those nations which are prepared to accept the essential limitations of sovereignty should proceed. The first question has been pressed by two of the scientific workers who worked in the Oak Ridge gaseous diffusion plant, Mr. Cuthbert Daniel and Mr. A. M. Squires, who have suggested that for the present not even the atomic development authority should either mine or process fissionable materials or operate reaction piles which would yield significant quantities of nuclear fuel, and that production of weapons and further weapon research should be stopped. With the setting up of international inspection, the authority would take over all existing plans and stocks together with the 'secret', and it would also arrange for an approved allotment throughout the world of all the fissionable materials required for other purposes, but would destroy all surpluses and dismantle the plants.

Such a plan bids high for Russian agreement, and might secure it; but the vital question here is not whether the advantages to be gained from the industrial use of atomic power are worth the risks of the bomb which they incur. It is not simply a question of whether it is worth taking an avoidable risk for the sake of what might be gained at the power stations in the next twenty years. The question is rather, is the risk avoidable? To put it bluntly, could the United Nations trust Russian adherence to such an undertaking in the absence of such an inspection system as is proposed by the Atomic Energy Commission itself?

If we cannot give ourselves a satisfactory answer to that question of good faith—and recent developments make that increasingly probable—we are left with the security issue paramount, and the question becomes whether we should go forward without the U.S.S.R. with the development of an atomic energy authority. There can be no doubt as to the dangers and difficulties of such a course, but equally we should not overlook the value of a practical demonstration of the possibility of an international system even within a limited field. If the United States, Great Britain and a number of other like-minded States could demonstrate to the world that the essential sacrifices of national sovereignty were, in fact, being made, and that the system was working satisfactorily, the all-important first step would have been taken and nations at present inclined to stand aloof might come in. But participation now or at a future date presupposes just that goodwill, that confidence and mutual respect which the U.S.S.R. is disposed to deny to those who are unwilling to be over-ruled by her authority. Whether even in the field of science those relations of trust and understanding can be established, in the face of restrictions on movement and such restraints on communication of scientific and technical information as those of the new Russian law on disclosure of State secrets, may be doubtful. It seems clear, however, that in this field of atomic energy, as in wider fields of science, the scientific worker can only seek to move forward on the line that the discipline and tradition of science have taught, avoiding so far as possible all that could exacerbate feelings or confuse the issue, testing each hypothesis and trying out the most promising in a limited field if necessary, and extending the experiment as the results indicate and opportunity offers.

THE DEVELOPMENT OF BRITISH CHEMISTRY

The Chemical Society, 1841–1941

A Historical Review. By Tom Sidney Moore and James Charles Philip. Pp. 236+10 plates. (London: Chemical Society, 1947.) 12*s.* 6*d.*

British Chemists

Edited by Alexander Findlay and William Hobson Mills. Pp. 432+16 plates. (London: Chemical Society, 1947.) 18*s.*

FOUNDED in 1841, the Chemical Society was the first nation-wide organisation concerned exclusively with "the advancement of chemistry and those branches of science immediately concerned with it". It led the way to the foundation of similar societies in France (1857), Germany (1867), and the United States (1876). Among permanent records of the recent centenary celebrations, the Society has issued these two appropriate volumes. They abound in material of abiding interest to all lovers of chemistry, and are truly worthy of the historic occasion.

The first volume traces in detail the foundation and growth of the Society. It is a story of modest beginnings, of growing pains, and of many later vicissitudes; but the curve of progress ascends steadily with the passage of time. Of willing and devoted members and officers there has never been a lack in this Society.

The tasks have passed from hand to hand, from generation to generation; but they have always been fulfilled.

As we read, the story grows into one of expanding activities and increasing complexities of organisation and administration, brought about by the astonishingly rapid development of chemistry and of the chemical profession in Great Britain. When one considers the handicaps under which the Society has laboured, its accomplishments appear all the more remarkable. The greatest handicap of all has been for many years the lack of housing accommodation. "The Meeting Room . . . is filled to suffocation at discussions and can seldom be used for lectures . . . after a century of public-spirited activity the Society is housed in premises which in no single respect are even tolerably adequate for its nationally important work." The Society provides the main channel in Britain for the publication of research in pure chemistry, and houses a national chemical library; yet, to take one problem alone, it is called upon to operate in these confined quarters "a library of 44,000 volumes growing at the rate of about 1,000 volumes a year, to the use of which 15,000 individuals are entitled".

The narrative, which is embellished with ten illustrations of much historic value, throws light upon the foundation of other organisations of chemical interest, such as the Institute of Chemistry, the Society of Chemical Industry, and the Association of British Chemical Manufacturers. To a large extent these and still other organisations may be regarded as offshoots of the Chemical Society, and it is a satisfactory feature that a growing co-operation has taken place in recent years between the numerous British societies owing an ultimate allegiance to chemistry. It is to be hoped that this tendency, which means so much for British chemistry, may lead ultimately to the realization of Pope's ideal of a 'Chemistry House' to accommodate all the chemical organisations, thereby releasing the Chemical Society from its cramped quarters in Burlington House, London.

Although the first of the volumes under notice deals primarily with the organisation and growth of the Society, it throws many interesting sidelights upon past presidents and others who have been closely concerned with that organisation and growth. It is illuminating, for example, to find Liebig writing of England as "the country which I love like my own Fatherland"; and to discover Victor Meyer sitting between Roscoe and Hugo Müller at the jubilee dinner of the Society (1891) and talking of "Kekulé, as, buried in thought, he rode home on the top of an omnibus through the streets of this great metropolis, after spending an inspiring evening with my neighbour on my left, his friend Dr. Hugo Müller". Those were truly days of internationalism in chemistry.

In these pages, too, we encounter the doughty H. E. Armstrong, the 'grand old man' of British chemistry; Vernon Harcourt, whose "long sentences were as precious to him as to Henry James; but he swayed them with equal skill and we would sigh with relief when the soothing and beautifully modulated voice emerged successfully from a seemingly hopeless tangle"; Tilden, with "that shade of dignity which has now become old-fashioned but remains precious"; Philip, the range and quality of whose personal services is probably the greatest in the history of the Society; Meldola, who traced his descent through sixteen generations back to Israel Meldola, born at Toledo in 1282; Ramsay, P. F. Frankland, W. H. Perkin, jun., Pope, Morgan, Greenaway, the courtly and upright G. G. Henderson, and many another. Here is a richly variegated human tapestry.

The main theme of the first volume is the development of the Chemical Society. Happily, however, as just indicated, the account includes also numerous short personal sketches of eminent British chemists who have served the Society in their day and generation. This is a particularly valuable feature to the humanist in chemistry; for the second volume, which is complementary in scope, deals solely with the personalities and researches of a strictly limited number of British chemists of this period. Naturally, in a volume of this size, it is impracticable to give full-length studies of more than a select few of the outstanding figures. These range in chronological order from Crookes, who was a boy of nine when the Society was founded, to Barger, born in 1878.

Here we find worthy biographical sketches of sixteen British masters who have died since the outbreak of the First World War. Some of these memoirs have been specially contributed by writers with first-hand knowledge; others are reprinted or adapted from existing memoirs. The volume, which has been skilfully edited, contains an account of the life and work of each subject, together with a portrait. It fills a gap in biographical chemistry which has persisted for too long; for although the Chemical Society has published several volumes of memorial lectures of much dignity and charm, dealing with distinguished foreign chemists, it has been unduly modest in this respect about its own members. Now that the ice has been so admirably broken, the hope may be entertained that future volumes of a similar kind will be forthcoming in due season. These might perhaps to some extent be retrospective, so as to include not only British masters of the future, but also some more of the chemical past masters of the British Commonwealth of Nations—such as Purdie, in Scotland, Orme Masson and H. G. Smith, in Australia, and P. C. Rây, in India—for whom space could not be found in this inauguratory volume.

In conclusion, it is pleasing to note that the cost of these two volumes has been generously defrayed by the printers, Messrs. Richard Clay and Company, Ltd., who have done so much yeoman work for the Society, as a contribution to the centenary fund. Together, the two volumes form a contribution of such high interest and value that they will inevitably find a place upon the bookshelves of all who have a lively interest in chemistry. JOHN READ

VEGETABLES OF HONG KONG

Vegetable Cultivation in Hong Kong

By G. A. C. Herklots. Pp. iv+208. (Hong Kong: South China Morning Post, Ltd., 1947.) 12 dollars.

BOOKS on gardening are many and varied, but few volumes can have made a more dramatic entry to a localized horticultural community. Born during the incipient siege of Hong Kong and nourished during a forty-three months 'sojourn' in the Stanley Civilian Internment Camp, the book holds the attention of even a Western reader. It must have a far greater significance in the region for which it is particularly written. The volume describes about a hundred kinds of vegetables, giving cultural details, discussing varieties, recipes and food values. Chinese names and ideographs appear in the text, and most species are illustrated by very clear but artistic line drawings. Woven through these foundation strands, however, is a very modern exposition of horticultural science. This is, of course, particularly adapted to Chinese conditions; but is a graceful blend of simple, age-old methods with modern scientific achievement. One learns how to compost organic matter with human urine and also the use of D.D.T. for pest control. 'Canton mud' settling from ponds where fish are fed on human excrement still provides a source of garden fertility, and yet weeds are now controlled by 2:4 dichloro-phenoxyacetic acid.

Horticulture in Hong Kong brings its own special problems. Seeds must, in general, be kept dry until planted, being packed in lead envelopes, and even stored in a desiccator. Periods of dormancy and of seed life are very short; parsnips and rhubarb provide good examples, while *Hippeastrum* seeds should be sown within a day or two of dehiscence from the capsule. New Zealand spinach seeds, on the other hand, germinate more vigorously after a year's storage. Hong Kong soils vary from porous lateric sand to an impermeable clay, but all are poor in major plant nutrients and most are too acid for good growth of vegetables. Several pages are accordingly devoted to the improvement of the physical and chemical nature of the soil. Temperature limits the growth of some plants, as the English cabbage, to the winter in Hong Kong, but tropical warmth from May until September permits the growth of many plants from the torrid zone. Periods of high humidity in March and April provide good conditions for the spread of fungal diseases in those months. The relatively short day makes it impossible to grow European varieties of onions for bulb formation. Seed potatoes from England do not grow well in Hong Kong, but several short-day potatoes from the Empire collection at Cambridge have been flown there and are now under trial. Other adaptations to special conditions are discussed in this book.

Many English friends of Dr. Herklots will value this publication, not only for its scientific and horticultural worth, but also as marking a vigorous return from the trials of internment. It seems possible to read between the lines, to imagine the difficulties at Stanley camp, and to admire the persistence which produced this most useful book. It would have been a credit to a similar study made in freedom.

John Grainger

AMERICAN METHODS AND PRACTICE IN AIR SURVEY

Manual of Photogrammetry

Edited by P. G. McCurdy, L. A. Woodward, J. I. Davidson, R. M. Wilson and R. E. Ask. Pp. ix+819. (New York, Chicago and London: Sir Isaac Pitman and Sons, Ltd., 1944.) 45*s.* net.

THIS manual has been produced by the American Society of Photogrammetry, some sections having been previously published in *Photogrammetric Engineering*, the journal of the Society. The Society is a very active one, and its journal regularly provides valuable technical information. Its membership extends overseas, including some from Great Britain.

The manual is composed of contributions by some thirty eminent members, together with sections from official and commercial sources. It has been edited by a small committee and presents an up-to-date picture of aerial photogrammetry with reference to American practice.

The range of subject-matter is wide: from the principles of surveying, optics, photography, perspective, and stereoscopy, to the basis and practical application of graphical, analytical and instrumental methods of mapping from air photographs. The chapters in themselves are self-contained.

One of note is that on mapping from obliques, which is dealt with in some detail. Practice in Canada, where considerable areas have been covered by obliques for reconnaissance mapping, is described, as is that developed by the American Geographical Society, with particular reference to exploratory surveys. Most important, however, is the section on trimetrogon mapping, in which three wide-angle cameras are used—one vertical and two lateral high-obliques—so that a lateral strip is covered from horizon to horizon by each set of exposures. By use of primary trigonometrical control, or independent astro-fixes, a rapid and effective method is available of reconnaissance mapping at scales of 1/250,000 or 1/500,000. Many hundreds of thousands of square miles were mapped by the U.S. Army Air Forces during the recent War in connexion with the charting of air routes over undeveloped country.

Another important chapter is that on radial line plotting, where, in addition to the usual graphical method, descriptions are given of its 'mechanization', by slotted templates or by mechanical radial arms.

The chapter on American survey cameras, mostly of Fairchild manufacture, is in the nature of a catalogue. No foreign types are described.

The manual is a mine of information on practical detail, evolved as a result of lengthy experience in the methods described; but it suffers inevitably from its preparation by a large number of contributors. Some aspects are omitted altogether, others sketchily treated from a scientific point of view, while there is some overlapping between the chapters, due to different authorship and separate publication.

It can by no means be considered a text-book of the subject, since no attempt is made to present a balanced and logically developed treatment. It is surprising, for example, to find that there is no reference to precise three-dimensional instruments such as those of Wild, Zeiss and Poivilliers, or of British designs, since instruments of this class are now recognized as having important applications in air survey. Also the title should be more properly "Manual of Aerial Photogrammetry", since there is no reference to ground photogrammetry. The edition is, however, a provisional one, so it is to be expected that some of these anomalies will be omitted in subsequent editions.

The final chapter on nomenclature and definitions is particularly welcome, and although some of the terms are at variance with British practice, it is to be hoped that it will not be impossible in the future to standardize.

The manual will prove a valuable reference work to air surveyors so long as it is recognized that it refers to American methods and instruments only. There is little critical comparison between the various American instruments and methods, some of which have been described by those commercially interested in them. Neither is there any description of, or comparison with, methods and instruments used extensively outside the United States, in the British Empire and elsewhere.

C. A. Hart

OPERATIONAL RESEARCH IN WAR AND PEACE

A DISCUSSION on operational research in war and peace was held by the Division of the Social and International Relations of Science of the British Association, during the Dundee meeting of the Association. The chair was taken by Dr. C. H. Desch and the discussion opened by Sir Robert Watson-Watt. Other speakers included Dr. O. H. Wansbrough-Jones, Prof. S. Zuckerman, Prof. W. C. Wilson, Prof. F. A. E. Crew, Mr. L. Moss and Prof. J. D. Bernal.

Sir Robert Watson-Watt said he believed that responsibility for the term 'operational research' rested with himself. He had no recollection of any positive definition, which did not emerge until late in the work, although it contained something of "doing arithmetic for Air Staff", market and consumer research, and the less naively offensive elements of motion study. Neither did he recognize the description of operational research by the president of the British Association, Sir Henry Dale, as that "which estimated destructive effects and planned destructive policy". If terms of reference were needed, he would suggest these, for industry as well as in war :

"To examine quantitatively whether the user organisation is getting from the operation of its equipment the best attainable contribution to its overall objective, what are the predominant factors governing the results attained, what changes in equipment or method can be reasonably expected to improve these results at a minimal cost in effort and time, and the degree to which variations in the tactical objectives are likely to contribute to a more economical and timely attainment of the overall strategic objective."

Operational research, Sir Robert proceeded, is beginning to look very like real scientific management, and he believes that it is an important contribution to the still unsolved problem of the relationship between the administrator and the expert. The essence of that licensed busybody, the operational researcher, is that he has learnt about things and about people; that he "lisps in numbers, for the numbers come", and that he is believed by the individual user of technical equipment because he and his like have been shown capable of ensuring great improvements in the performance of the equipment and in the comfort, security and self-fulfilment of the user. In war, the pioneer practice in the R.A.F. might be described as having been centrifugal, certainly as highly devolutionary, and the naval counterpart was by contrast highly centralized. In peace, Sir Henry Dale had a right to ask whether "we can accept as directly obvious the suggestion that Operational Research . . . would qualify for guidance in the immeasurably more complicated and fundamentally different problems of reconstruction". It would be disastrous if this legitimate query were misread and misapplied as a positive statement of rejection. Sir Robert doubted whether the peace ensemble is, in fact, more complex than the war ensemble, nor could he perceive any fundamental difference between the problems within a peace-time industry and those on one side of the gulf of war. The argument, he considered, was "desperately important" and he said he meant every syllable and stress of those words.

In conclusion, it was with profound regret that he had heard Sir Henry Dale speak of the "conscription of science". All that was asked by those who believed in the present application of operational research, and felt that "the rocks might crumble beneath the ivory city", was that they "be given the academic freedom of operational research to measure the facts, the dangers and the towering possibilities".

Dr. O. H. Wansbrough-Jones, speaking of Army applications, stated that the method should have improved on that recommended by Newton for navigational technique by the introduction of better statistical and other scientific tools ; and on current methods of administrative planning in the Army by giving greater freedom both in opportunities of direct observation and of freedom from daily routine. Also, although successes might rightly be claimed by those who did the work, their scientific training and objective approach would have been insufficient if there had not been a readiness, especially at high levels, to receive, absorb and encourage these scientific men and to heed their results ; if there had not been a few outstanding men of science to lead the work, as well as a sufficient body with a good knowledge of the ways, tasks, and difficulties of the Army ; and, pervading it all, the intense stimulus of national need. Unless each condition was met, at least in part, this type of work would not be useful.

Home sections were formed during the War to study tank gunnery, field artillery and infantry weapons, and the process culminated in the provision of a further six sections to work in theatres of operations. Up to the end of 1945, some 365 scientific workers were employed in operational research on behalf of the army, the maximum number employed at any one time being about 174. Up to date, they had produced some 380 reports of varying importance roughly equivalent in size to the average scientific paper, and nearly 600 memoranda of smaller importance, besides dealing with a very large number of day-to-day queries. Those at home had worked under the Ministry of Supply, and the overseas sections under indirect War Office control. The present scientific force is very much reduced, and the division between the Ministry of Supply and the War Office still remains, but the relationship is very close and likely to become closer.

Taking two overseas sections as examples, that with 21st Army Group had a maximum strength of twelve. It was in the theatre of operations from D-Day until July 1945, and produced some forty reports covering a variety of subjects most of which had been suggested by the investigators themselves. Those first selected, after a few weeks of initial study, were the location of enemy mortars, the distribution of hits and penetrations in our own and the enemy's tank casualties, the performance and best method of use of the PIAT, the problem of dust on roads and airstrips, and the examination of mud. Of these, that on dust was taken over by the Air Force, that on mud proved too valuable, and the PIAT work was mainly technical ; but the mortar location and tank casualty work was completed with good results. The report on the first was the factual basis of the counter-mortar organisation later set up with 21st Army Group : that on the second provided accurate data on how armour should be distributed on tanks fighting in close country. Work was also continued on the two basic problems of air and artillery bombardment, and events led the operational researchers back to them. Among the results was the first objective assessment of the effects achieved by a given weight of bombing in support of ground troops.

The corresponding section with the 14th Army in Burma determined maintenance tonnages and man-power wastage. In the event, the application of these two studies to the planned assault on Malaya and Singapore remained untested. As to the need in such work for highly trained scientific workers, Dr. Wansbrough-Jones suggested that, although operational research probably did not demand such training, it was greatly helped by scientific training. "It is much more", he stated, "than the straightforward collection of facts and the writing of histories; it must continually seek out new sources of information, especially the least obvious, and by sound reasoning from the facts, provide a new understanding of its particular problem." In peace the emphasis falls naturally on training and administration, and it is hoped to study, in particular, the adequacy of the existing motive of Army service, means for increasing its value, and the effectiveness of substitute motives such as group or individual rewards, the acquisition of knowledge and skills, and the use made of synthetic trainers of various types.

Dr. Wansbrough-Jones believes that for some young scientific men, those really interested in the social applications of science, diversion for a time to operational research, but not for too long, would be not only justifiable but desirable. With adequate safeguards, and good career control, it would be an advantage to many to work for a year or so, say in their late twenties, for a Government department; to leave industrial laboratories to work on the scientific man-power sides of their industries, and defence laboratories to work with the Services. Army plans for the last are being put into force.

Prof. S. Zuckerman distinguished between operational research at the technical, tactical and strategic levels. At the first level was an investigation of the manner in which bombs cause casualties, and it was at this level that the better part of the scientific man-power engaged with the Fighting Services during the War was employed. Operational research into different kinds of tactics and methods of organisation consumed the bulk of the remaining effort. One example was the relationship between different types of formation-flying and accuracy of bombing. Scientific men, with their understanding of the techniques involved, appreciation of the tactical problems to be overcome, and emphasis on objectivity and statistical method, can arrive at solutions about tactics which could have been derived only accidentally by other methods. Scientific intervention at the level where major strategic policy is determined was slight—although it would have been impossible for the Ministries of Food and Home Security, for example, to take reasonable decisions on policy without the constant help of expert knowledge, fortified in one case by nutritional surveys and in the other by a large organisation working experimentally and in the field. On the military plane, however, most major operational policy was determined without recourse to scientific advice, and examples of scientific intervention are thus few. Lord Cherwell, as Paymaster-General and scientific adviser to the Prime Minister, was no doubt able to bring scientific method to bear on decisions affecting major policy. In addition, two specific examples were quoted. In the anti-U-boat campaign, scientific analysis not only helped to determine the convoy system, but also assisted in showing the value of diverting four-engined bomber aircraft to U-boat patrols. The second concerned the strategic policy underlying the employment of heavy bombers against the enemy. Objective and quantitative analysis showed that the bomber offensive against German industrial cities was not depressing the level of German production to the extent hoped for, but that attacks against communications would have a far-reaching and immediate effect. Revision of strategic policy in the spring of 1944 was based on this objective appreciation, which was confirmed by subsequent examination in Germany.

What was true about the value of scientific method during the War is no less true to-day, Prof. Zuckerman proceeded. War is not a state of unfettered individual enterprise, any more than unfettered individual enterprise could be the characteristic of the present economic and political state of Britain or Western Europe as a whole. The Government has added to the normal function of administration executive duties which make it necessary either that officials should lean more and more upon scientific advice or become more and more scientific themselves. Cabinet planning bodies such as that presided over by Sir Guy Plowden, and the Advisory Council on Scientific Policy presided over by Sir Henry Tizard, may be regarded as operational research sections established at a strategic level in the economic field. As the situation develops, the function of such different bodies may find a common meeting-ground for the exposition of the major economic, scientific and administrative problems which have to be taken into consideration in a fruitful peace-time strategy.

Prof. W. C. Wilson described the work of No. 1 Medical Research Section in the Middle East between May 1942 and April 1943. Its mandate covered all matters concerning the welfare of fighting men in a very large territory with several distinct and varied climates. The reports of Dr. A. L. Chute, a Canadian physician and physiologist, gave extensive factual data on wounds, evacuation of wounded, fatigue, effects of stress, hours of sleep, food, appetite, cooking and other aspects of tank fighting. Dr. E. T. C. Spooner, a Cambridge bacteriologist, undertook a general survey of Middle East conditions, and studied the typhus situation in Egypt, desert sores, and the outbreak of infective hepatitis of late 1942. Prof. Wilson's own work was on the problems of burns and 'wound shock'. Points which stood out in retrospect were the value of a section composed of independent, full-time and fully mobile observers; and the conclusion that minority opinions should not be ignored, even when counter to expected results. The shortage of trained medical investigators had proved a handicap, and Prof. Wilson was not optimistic that it could be easily or quickly remedied. But if the latent forces of interest and idealism in the medical profession could be mobilized, they might provide a research weapon of immense power in new fields such as social medicine.

Prof. F. A. E. Crew discerned two phases in the application of scientific research in a protracted war: the first in which the production of machines and materialities were the essential preoccupation, and the second in which these were gradually overtopped by problems of the health, morale and efficiency of men. It had been expected that the Army Council would refer to the Medical Research Council any problem of urgency and military importance which fell into the sphere of the biological sciences; but this arrangement did not work, and Sir Edward Mellanby had ultimately created a field investigational organisation which provided the model, so far as he knew, for what was later done by the Army itself. Lessons for the future were that the nature, and even the existence, of a problem of quite serious importance could remain unrecognized until investigated by selected and highly trained scientific workers; that mixed teams are required, of compositions determined by the probable nature of the problem; that hopeful investigation depends on willingness on the part of the community to participate actively; that results, however potentially valuable, can remain disregarded until thoroughly appreciated at the topmost levels; and that for rapid solutions, simultaneous investigation in different circumstances by different teams is a very great advantage. The only danger is that, with the return of peace, the Medical Research Council might find it necessary to withdraw from social biology.

Mr. Louis Moss, director of the Government Social Survey, referred to the need for studies of both the social and industrial conditions of particular jobs, as well as of the attitudes of potential recruits, if labour were to be induced rather than compelled to particular industries.

Prof. J. D. Bernal, as the last speaker, was handicapped by the length of discussion which had already taken place, and what follows is based on the written contribution which he had intended to make. The same needs, he contended, that led to the appearance of operational research in war should now lead to the conversion of that experience to peaceful uses, since the gap between imports and exports and the impossibility of Britain feeding itself are at least as serious and immediate as any war situation. 'Operation Production' should be considered with the same urgency and common purpose as 'Operation Overlord'. The technique of operational research could be made available to find out what has to be done, to check the success of the operation and modify its conduct. It is essential that the country's very limited resources in trained man-power in engineering and science should be used in the most effective way with a scientifically determined system of priorities, weighing not only present resources, but also those which could be increased, often by very large factors, by the application of high-pressure research and development. Only a combination of economists, engineers and scientists could achieve this; but they must operate on the highest planning authority in the country. The most obvious priorities are coal, steel, building and agriculture; but others such as transport, distribution and the utilization of chemical wastes may prove equally important. Prof. Blackett's general principle of operational research should be used, to do those things which combine the greatest need with the most rapid possibility of achievement.

All these are in the nature of economic planning, but physical research is required wherever materials and techniques have to be transferred from their present use to some new one. Lively and effective research would also be necessary on the workshop and farm level, and all the ingenuity in the country would be needed to solve the thousand small problems that would arise. Thousands of scientific workers and engineers are being used in a wasteful manner or for purposes of secondary importance—a very large number in industry and probably as many in Service research. Operational research is needed to find the best distribution and to check redistribution. It would be tragic, he concluded, if this one organisational development of the War were not given the chance to show its capacity in the peace.

THE INSTITUTE OF SEAWEED RESEARCH

"HERE, Scotland has a chance. Eire, Norway, America, Japan, have all, in varying ways, exploited their seaweed resources. We are only at the beginning, and this splendid research station gives us the opportunity not only of making up on these countries, but of surpassing them." So declared the Right Hon. Joseph Westwood, Secretary of State for Scotland, when, on September 19, he officially opened the headquarters of the Scottish Seaweed Research Association—the Institute of Seaweed Research, Inveresk Gate, Musselburgh, Midlothian. Until recently a large mansion house, Inveresk Gate now contains adequate botanical, chemical, engineering and photographic laboratories, engineering workshops, a drawing office, a library, and conference and display rooms, apart from the necessary offices. The Institute stands in eleven acres of ground, and is situated sufficiently near Edinburgh, the University, and the sea to meet the Association's various needs.

The Association was formed in June 1944, and until Inveresk Gate became available the director and staff used the King's Buildings (of the University of Edinburgh) A.R.P. Control Centre as offices, as well as certain of the University's research laboratories and facilities. During the first two years of its life the Association was financed by means of a grant of £25,000 from the Development Fund. Thus was made possible a survey of Scottish seaweed resources and investigations into methods of harvesting, handling and processing these resources. Now, Government has provided over a period of five years a further sum of £90,000, and it is hoped that at least another £10,000 will be forthcoming from industry, and from public-spirited individuals.

Dr. F. N. Woodward is director of the Institute, but at the moment has been seconded to act as director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Office in Washington. The acting director is Major P. Jackson. Under this joint direction the staff of the Institute operates under three divisions: botanical, chemical and engineering. The activities of these divisions may be outlined, as in the director's report, as follows:

(1) *Survey of Scottish seaweed resources.* (*a*) Development of reliable survey methods. (*b*) Quantitative survey of the Scottish coast for littoral, sublittoral and cast brown weeds. (*c*) Study of economic and ecological factors. (*d*) Determination of optimum conditions of growth by controlled culture.

(2) *Harvesting and processing investigations.* (*a*) Development of economic harvesting methods. (*b*) Determination of optimum conditions of drying, grinding and processing.

(3) *New and extended uses of seaweed and seaweed products.* (*a*) Determination of the chemical composition of Scottish seaweeds and its variation with change of species, season, age, environment, etc. (*b*) Determination of the properties and characteristics of the chemical components of seaweed and their derivatives, with the view of finding new and extended uses. (*c*) Development of methods of production of such constituents and their derivatives as are of potential technical value. (*d*) Determination of the value of seaweed as a component of animal feeding-stuffs and as a fertilizer.

Superimposed upon this programme, and as a logical outcome of its partial completion, is the new problem which arose during 1946, that of endeavouring to establish in the Outer Hebrides a ground, dried, rockweed producing unit.

At this stage it may not be out of place to outline briefly the activities of the three Divisions. Acting head of the Botanical Division is Mr. F. T. Walker. He and his assistant algologists have had to solve one of the two main problems facing the Association, namely, whether or not there is enough weed on Scottish coasts at a density sufficient to warrant commercial utilization. Accordingly, a littoral weed survey was commenced in April 1945 and concluded in December 1946. During this time, 4,250 of the 4,630 miles (92 per cent) of practical Scottish coast, exclusive of the Shetlands, were covered and more than 180,000 tons of littoral weed estimated to be present. The most prolific area apparently is in North Uist, where Loch Maddy and Loch Eport support a total of about 60,000 tons of littoral weed. On the basis of this estimation and full-scale trials now nearing completion it may be feasible to establish a harvesting and processing unit in Loch Maddy. One of the most prolific areas for sub-littoral weed is likely to be found around the Orkney Islands, where the sea-bed between one and six fathoms (low water) has been estimated to support well over 1,000,000 tons, perhaps nearly 2,000,000 tons, of seaweed of the family Laminariaceæ. The species of this family most common to the Scottish coast do not apparently grow in measurable quantities below nine fathoms (low water), and to harvest at depths below six fathoms (low water) would be quite uneconomic. A further survey of the sub-littoral seaweed growth around the Orkney Islands, and, if possible, of other rich algæ-bearing areas in Scottish waters, is part of the programme of the algologists for 1947–48, using techniques developed in the Association's laboratories. Other aspects of their researches include a survey of the cast seaweed during the winter months of 1947–48, a determination of the rates of regrowth and recolonization of the Fucaceæ of Orkney, an estimation by controlled cultural methods of the minimum requirements for successful growth and development of the British Laminariaceæ from zoospore stages, and the induction of polyploidy in the Laminariaceæ by chemical and physical means. Moreover, several extra-mural investigations are in progress. Dr. Delf and Miss Moss of Westfield College, London, are studying the concentration gradients and constitutional and physiological differences in the Fuci from areas of varying exposure, and Prof. Bennet-Clark and Mrs. Milnthorpe, of King's College, London, the metabolism of respiration of the Laminariaceæ.

Meantime, one can say with safety that the Botanical Division has shown that sufficient seaweed is available in Scotland to make the seaweed industry a commercial proposition, *if the seaweed can be harvested.*

The harvesting of the seaweed is, of course, the second of the two main tasks confronting the Association, which stands or falls by its ability to solve the problem. This is the problem of the Engineering Division headed by the deputy director of the Institute, with Mr. Wm. Mackenzie, who has been with the Association since its inception, as second in command. Seaweed growing in the littoral zones is comparatively easy to harvest; and methods of harvesting have already been devised and are being developed. Sub-littoral seaweed, growing on the rocky sea-bottom at depths of between one and seven fathoms (low water), is much more difficult to harvest. In most parts of the Scottish coastline it grows fairly close inshore and necessitates the use of powerfully engined, shallow draft, and easily manœuvrable vessels. Therefore, before embarking on a costly series of experimental investigations, the Engineering Division has contacted upwards of thirty engineers and interested members of other professions in the universities and colleges, Government departments, Government and other research organisations and in industry with the view of obtaining as many suggestions and constructive criticisms of existing ideas as possible. As a result, the problem has been considerably clarified, and now six possible methods have been evolved which are considered worthy of full-scale investigation. Already the first two experimental units, operating on different principles, have been designed and all the necessary equipment ordered, and shortly the first trials will start off the west coast of Scotland. Meantime, during much of the past year the engineers have had to devote themselves to matters associated with the lay-out, furnishing, servicing, equipping and the adaptation of Inveresk Gate to the Association's needs.

Assuming, then, that the necessary apparatus for the harvesting of the sub-littoral seaweed will be evolved, the main object of the Scottish Seaweed Research Association will be the development of seaweed as a source of chemicals. So far, the only seaweed product that is being used commercially on a large scale is alginic acid; but for every ton of this acid which is extracted, there are three tons of potentially useful chemicals running to waste. Obviously, the Chemical Division, headed by Dr. W. A. P. Black, has a huge field for research, and many problems have been initiated. Several of these are extra-mural investigations at certain universities and research establishments, either on a contractual or on a collaborative basis. Dr. Percival, at the University of Edinburgh, has developed accurate methods for the estimation of alginic acid, laminarin and mannitol, and is also directing research on fucoidin. At the University of Manchester, under the direction of Prof. E. L. Hirst, the chemistry of alginic acid and laminarin was being investigated. Perhaps this work will now also be conducted in Edinburgh, in view of Prof. Hirst's recent appointment to the new Forbes chair of organic chemistry in this University. At the Imperial College of Science and Technology, Sir Ian Heilbron and his colleagues Dr. L. N. Owen and Dr. A. H. Cook are studying the brown seaweed lipoids and the chemistry of the algal reproductive processes. Algal sterols are being studied at King's College, London, by Prof. D. H. Hey; while at University College, Nottingham, Dr. D. O. Jordan with the late Prof. J. Masson Gulland was attempting to isolate and identify the unknown constituents of the brown seaweeds by electrophoretic methods.

During the past two years the staff of the Chemistry Division has been working on the seasonal variation in the composition of some common brown algæ. For example, in 1946, some 144 samples of littoral weeds of the family Fucaceæ, *Pelvetia canaliculata*, *Fucus spiralis*, *F. serratus*, *F. vesiculosus* and *Ascophyllum nodosum*, and of sub-littoral weeds of the family Laminariaceæ, *Laminaria digitata*, *L. saccharina* and *L. Cloustoni*, have been collected and prepared under strictly controlled conditions, and their dry weight, ash, iodine, nitrogen, mannitol and alginic acid contents determined. It is of interest to note that the results recorded for 1946 are comparable with those obtained for 1945; indicating that the results may be approximately reproducible in subsequent seasons.

Another problem of much scientific and technical importance is a study of the variation in the composition of the sub-littoral seaweeds with depth of immersion. So far, the results obtained substantiate the hypothesis that, consequent upon depth of immersion, there is a decrease in light intensity affecting the photosynthetic processes, which is reflected in the composition of the weeds.

The above programmes of research and development have been approved by the Board of Management under the chairmanship of Sir Steven Bilsland, who is also chairman of the Scottish Council (Development and Industry), as well as by the three specialist Advisory Committees, Algological, Chemical and Engineering. At the official opening of the Institute, Sir Steven emphasized that Scottish seaweed could provide an industry worth £15,000,000 per annum. Of this sum one third would go to collectors. In all, 90 per cent would be spent in Scotland and only 10 per cent outside Scotland.

Thus, for the first time, there has been sponsored in Great Britain an organisation set up to develop an industry based on waste, indigenous, natural products. It is interesting and suggestive to recall that it is now more than sixty years ago (1884) since Stanford, employed in the Scotch kelp industry, first discovered algin and some of the substances contained therein—calcium, magnesium and sodium in combination with the new alginic acid.

H. R. FLETCHER

MECHANISM OF COLOUR VISION

ALTHOUGH some references were made to visual investigations carried out for the Forces during the War, the International Conference on Colour Vision held at Cambridge during July 28–August 2 was concerned mainly with the fundamental problem of how the visual mechanism works and, in particular, with the apparatus by which differences of colour are perceived.

R. Granit (Stockholm) reviewed the outstanding new development in this field, the work which he and his school have carried out on the electrical response of single fibres of the optic nerves of experimental animals such as the frog, cat, snake, etc. The response is picked up by applying a micro-electrode to the retina of an eye from which cornea and lens have been removed. Potential spikes generated between the micro-electrode and a second electrode, placed usually at the back of the bulb, may occur only on illuminating the retina (pure on-elements), or only on cutting-off the illumination (pure off-elements), or after both these operations (on-off-elements). But in every case a spectral sensitivity curve for the element which the micro-electrode has contacted can be measured by finding the smallest energy of various wave-lengths which just suffices to elicit a minimal characteristic response. Certain signs, for example, a single spike response at the threshold, enable the experimenter to decide whether the micro-electrode is in contact with the fibre of a single ganglion cell.

The following types of spectral sensitivity curve are obtained: (*a*) *scotopic dominator*, a broad curve which by its shape and position in the spectrum and by its appearance in rod retinæ and under conditions of dark-adaptation can be attributed to ganglion cells associated with end-organs for which visual purple (or, for freshwater fish, visual violet) is the photosensitive substance; (*b*) *photopic dominator*, another broad curve, obtained with light-adapted and predominantly cone retinæ, which is displaced some 60–70 mμ towards the red compared with the scotopic dominator of the same retina (when this can be recorded); (*c*) *modulator curves*, comparatively narrow curves obtained with light-adapted retinæ and located at various points of the spectrum from about 440 to 610 mμ, possibly in groups in the red, green and blue regions; (*d*) *composite curves*, which can be regarded as the 'summation' of a dominator and a modulator or of two modulators.

From replies to questions on the relative frequency with which dominator and modulator curves are obtained, it appeared that perhaps one in twenty curves (presumably for light-adapted retinæ) would be of modulator type. A new worker in this field, de Vries (Groningen) reported that he had had no difficulty in obtaining dominator curves, but had not yet observed a modulator curve.

Some criticism was expressed of Granit's second method of obtaining modulator curves, the method of selective adaptation. The modulator curve is derived by taking at each wave-length the difference between (*a*) the sensitivity (reciprocal threshold energy) of an element after strong adaptation to coloured light, and (*b*) the reduced sensitivity of the same element in the fully dark-adapted state, that is, the dark-adapted sensitivity reduced by a constant factor so chosen that the difference in question is zero at some wave-length and is nowhere negative. One of several assumptions underlying this procedure is that both rods and 'modulator receptors' are connected to the ganglion cell, the fibre of which is in contact with the micro-electrode, and that the effects of radiational quanta absorbed in rods and modulator receptors are summed at the threshold just as if they were all absorbed by a single end-organ.

Pirenne (London) and others found this latter assumption difficult to accept. Apart from the difficulty of justification, however, the procedure used leads to modulator curves for the cat's retina which are very similar to those obtained for other retinæ by the direct method.

Certain main trends relating the on-or-off character of an element with its spectral response and other properties had been observed. Thus pure on-elements were strongly predominant in pure rod retinæ, while pure off-elements were common in retinæ having no rods. Taking as standard the spectral sensitivity curve corresponding to light absorption by visual purple, Granit and Tansley (Birmingham) found that off-responses, particularly those from pure off-elements, were in general relatively red-sensitive, but on-responses, if they deviated at all, did so in the direction of blue-sensitivity. From these and similar results Granit was led to group together rods, on-effects and blue-sensitivity on one hand, cones, off-effects, inhibition and red-sensitivity on the other.

In the latest micro-electrode work, Granit and Gernandt (Stockholm) had found that if, instead of illuminating the retina, a polarizing current of about 0·1 mA. was passed through it, on-elements gave an on effect and off-elements an off effect for one direction of the polarizing current and the reverse effects when the current was reversed. On-off-elements behaved to the polarizing current either like on-elements or like off-elements, depending on the relative strengths of their on- and off-responses to the ordinary light stimulus. The effect of a polarizing current on the spectral sensitivity curve of an element was expressed by taking at each wave-length the *ratio* of the light thresholds with and without polarizing current. The ratio curves so obtained show peaks and depressions at various parts of the spectrum, different for different current directions and for elements of different type. These peaks and depressions are assimilated to the modulator curves obtained by the method of selective adaptation. In Granit's view the polarization method provides the most satisfactory way of determining modulators. The bearing of the polarization results on the question of inhibition in the neural network of the retina was also discussed by Granit.

A paper by Polyak (Chicago) on retinal structure and colour vision was read by Le Gros Clark (Oxford). Le Gros Clark also summarized the evidence for his interesting suggestion that conduction from the central retina is mediated by three-fibre units, the respective fibres terminating in corresponding cell layers of the lateral geniculate body, and that this triplicity is closely related to the trichromatic basis of colour vision. One supporting observation was obtained from a war-time experiment in which monkeys kept in red light for some weeks showed, in two out of three animals, a degeneration of the cell layers associated by other evidence with the 'blue' mechanism. Oddly enough, this presumed atrophy by disuse affected mainly the layer of 'blue' cells receiving crossed fibres. Two of the main points made by Polyak were that in the extrafoveal retina the ganglion cells are generally connected through bipolars to both rod and cone end-organs, and that in the central fovea the end-organs are structurally indistinguishable, although connected in different ways through bipolars to the ganglion cells.

The latter conclusion cuts across the hypothesis recently developed by Willmer (Cambridge), according to which the end-organs of the central fovea are of two kinds, cones and non-adapting or day rods. Willmer suggested that the staining reactions used by Polyak to identify rods might pick out only those which have the capacity of accumulating visual purple in the dark and might fail for day-rods. Willmer, after summarizing the phylogenetic argument for his hypothesis, presented some new sensory measurements on the luminosity curves of colour-blinds obtained with small test fields in the central fovea. Under these conditions, normal trichromats behave like dichromats (tritanopic), while dichromats are reduced to monochromats. The differences in the luminosity curves of various colour-defectives were correlated by Willmer with the several possible end-organ-ganglion cell systems consistent with his hypothesis. Also the actual shapes of the curves were related to the absorption curves of rhodopsin and iodopsin.

In the discussion, this last step was strongly criticized for the same kind of reason as already noted in connexion with Granit's derivation of modulator curves by selective adaptation. In fact, one main impression from the Conference was that workers on vision have been prone to take differences of experimental curves or to apply other mathematical manipulations to their data without a proper discussion of the kind of summation, inhibition or other process which is automatically assumed to occur in the organism whenever particular mathematical methods are applied.

Wald (Harvard) reviewed the considerable knowledge we now have of the rhodopsin–retinene$_1$–vitamin A$_1$, and the porphyropsin–retinene$_2$–vitamin A$_2$ photochemical systems of the retina. Morton (Liverpool), who has recently obtained retinene$_1$ in the crystalline state, explained briefly his reasons for attributing to retinene$_2$ a structure differing from retinene$_1$ by one additional conjugated double bond in the ring. The extraction by Bliss (Boston, U.S.A.) of a substance termed cephalopsin, a kind of non-bleaching visual purple, from the eye of the squid raised interesting possibilities. No substantial advance in the difficult problem of extracting from the retina photosensitive substances which might be assigned to cones or to hypothetical end-organs possessing spectral sensitivities of modulator type was reported. Wald showed how measurements of the absolute light threshold in the visible and ultra-violet for parafoveal rod vision and foveal and parafoveal cone vision on normal and aphakic eyes led to determinations of the absorption curves of the macular pigment and of the eye lens. The results were in satisfactory agreement with his direct measurements on preparations from human eyes. The macular pigment could be identified as a xanthophyll, probably ordinary lutein.

Turning to purely sensory studies of colour vision, MacAdam (Rochester, U.S.A.) explained how by the use of Landolt test objects (*a*) of usual type, (*b*) with the broken circle of one colour and the background of different colour but equal brightness, he had succeeded in comparing the visual acuities attributable respectively to pure brightness and pure colour contrast. Taking as standard the relative importance of colour and brightness contrast in determining the observed discrimination in a 2° colorimeter field, colour contrast was found to be much less effective in the acuity observations, which depend on discrimination in small areas. At the other extreme of large non-contiguous areas, colour contrast was much more effective than brightness contrast. As fixation was not controlled in the acuity measurements, the results were not directly comparable with those of Willmer and Wright (London) showing tritanopic colour defect in the central fovea, and, in fact, the loss of colour discrimination was not of this specific type.

Wright considered the recent work on colour matching and discrimination in small fields in his talk on the present status of the trichromatic theory. His general conclusion was that the theory in some form is necessary to explain some of the known facts and, at the same time, it is not inconsistent with much of the remaining data. According to Stiles (Teddington) the observed foveal thresholds of a coloured light patch superimposed on an adapting field of, in general, a different colour are consistent with a classical trichromatic theory and lead to fundamental response curves of König type. But from the threshold recovery curves obtained after extinguishing the adapting field, it appears that the 'blue' mechanism has very different dynamics from the 'green' and 'red' mechanisms, a result already indicated by Wright's studies of colour adaptation by the binocular matching method. The difficulty of reconciling three fundamental response curves which are widely separated in the spectrum (for example, curves of

König type) with the apparent saturations of different spectral colours was enunciated by Hecht (New York), who also raised the problem of the sensations experienced by subjects with one normal and one colour-defective eye.

In the discussion two issues were separated: (*a*) differences in the number of just perceptible colour steps between white and the various spectrum colours; (*b*) the relation between the descriptions of colour sensations given by normals and various types of colour-defectives. Wright argued that attempts to explain (*a*) on the basis of the trichromatic theory, while not without some success, were too mechanistic. On (*b*), it was suggested that the colour names applied by colour-defectives are determined during the development of the individual so as to give, under the conditions of everyday life, the greatest measure of agreement with the names used by colour normals; or, in the case of a single defective eye, maximum agreement between the names which would be applied when the two eyes were used in turn.

Judd (Washington, U.S.A.) found the explanation of the colour sensations experienced by colour-blinds the principal stumbling-block to the interpretation of dichromatic vision on the trichromatic theory. He summarized several alternative views according to which a different form of explanation of colour vision is required for the various stages (photosensitive, substance, receptor, optic nerve, cortex) of the visual process.

By measuring the foveal threshold sensitivity through the spectrum, Hecht had deduced that the effective luminosity of an equi-energy spectrum would be, for the protanope, about one half and, for the deuteranope, about three fifths that of the normal. On the assumption that luminosity is the dominant factor in determining differences of visual acuity between normals and colour-defectives, he tested and confirmed this result by acuity measurements on subjects of the three types. de Vries determined the modification in brightness match between green and red stimuli when the matching field was covered by a veiling brightness of red or blue light. The modified matches agreed with those obtained in the absence of the veiling brightness by protanopes and deuteranopes respectively. This result and that of Hecht appear to support the simple theory of dichromatism as the loss of a receptor system.

Pitt (Harrow) developed the interesting suggestion that for protanomalous trichromats only the 'red' fundamental response curve is aberrant, this curve being related to the corresponding normal curve by some modification of form, progressive with increasing anomaly, and perhaps resembling the change of the absorption curve for a layer of increasing thickness. Schouten (Eindhoven) put forward related ideas for both deuteranomalous and protanomalous cases. Hecht questioned the usual interpretation of anomaloscope studies of large groups as showing a continuous transition between the normal and the anomalous. By taking account of the whole range of uncertainty in each subject's setting of the anomaloscope, he concluded that the groups are clearly separable without overlap. Farnsworth (New London, U.S.A.) showed a pseudo-isochromatic chart, which he had designed and made up from Munsell colour patterns, for the detection of tritanomalous subjects, a type which is likely to have escaped earlier tests of colour defect. The genetics of colour vision were not discussed in any detail, but Kalmus (London) made a plea for the study of the colour vision of heterozygous females.

Of the several points raised by Hartridge (London) in developing a polychromatic theory of vision, his use of the negative values in sets of fundamental response curves like those of Wright as an argument for additional receptor mechanisms was not generally acceptable. On the other hand, Dimmick (New London, U.S.A.) and Schouten were sympathetic to certain aspects of the theory, which they consider are in better accord than the usual trichromatic presentation with the psychological analysis of sensation.

Measurements, by a new method, of the chromatic aberration of the eye, which is of particular importance in the recent studies of colour in small fields, were presented by Ivanoff (Paris). His results agreed satisfactorily with other new measurements by American workers. Hecht, Shaer, and Pirenne's notion of quantum fluctuations in the stimulus as the main factor in determining the intrinsic indefiniteness of absolute threshold values was discussed by Van der Velden (Utrecht) and Bouman (Utrecht). By extending the theory to take account of variations of threshold with the area and exposure-time of the test stimulus, they conclude that the absorption of two quanta is sufficient to initiate a response. Hecht reported new work on the effects on the threshold of the size and shape of the test stimulus. He found that the dominant factor is the length of the boundary edge rather than the area.

It was a great pleasure to all present to have the Conference opened by the veteran of the subject, Sir John Parsons.

W. S. STILES

OBITUARIES

Dr. Ellsworth Huntington

DR. ELLSWORTH HUNTINGTON, who died recently at the age of seventy-one, was well known for his views on the dominant effect of climate on human affairs. As a student of geography under Prof. W. M. Davis, he spent the years from 1900 to 1906 in the exploration of Asia Minor and Central Asia, his first paper being an account of the Upper Euphrates published in 1902. In Central Asia he was struck by the evidence that large populations formerly inhabited regions now arid and deserted, and from these and other historical studies, including the changes of level of the Caspian Sea, he developed the theory that during the past few thousand years there have been great oscillations of climate. These researches were published in "The Pulse of Asia" in 1907 and aroused much controversy among geographers. In the following years he extended his studies of climatic change to Palestine and North America, and he was one of the pioneers in the measurement of tree-rings as climatic indicators. These researches led him to the view that the ideal climate for human vigour is one of moderate but rapidly fluctuating temperatures, which is best developed in the storm-belts of temperate latitudes; and in "Civilization and Climate" (1915) he compared estimates of the level of existing civilizations in different countries, obtained in various ways, with their level of climatic energy, finding remarkably close agreement. In the same book he extended his studies of the effect of climatic changes on the history of ancient civilizations, including a new version of the decline and fall of the Roman Empire.

Huntington followed up these ideas in great detail in a series of articles and books—"World Power and Evolution", "The Pulse of Progress", "Weather and Health", "Season of Birth", "Mainsprings of Civilization", etc. He believed that the origin of climatic variations was to be sought in the sun, and especially in shifts of the storm belts associated with changes in sunspot activity. This hypothesis fits well enough with historical changes of climate; but he stretched it too far when, in conjunction with S. S. Visher, he based a theory of ice ages on increases in the number of sunspots. His rather wild hypothesis of the electro-magnetic influence of the fixed stars on solar radiation found no favour with astronomers. In his later years Huntington became interested in the study of weather cycles, and he was one of the originators of the Foundation for the Study of Cycles which was established in the United States.

Huntington's books were all eminently readable and full of ideas, but at times his claims were exaggerated; for this reason his books had less influence than they might have done had they been phrased more cautiously. On the other hand, he did much to arouse interest in historical variations of climate. In the early 1900's, climate was generally believed to have remained static for thousands of years; "The Pulse of Asia" shattered this calm and began a controversy which has added much to our knowledge.

C. E. P. Brooks

We regret to announce the following deaths:

Mr. William Densham, who assisted Marconi in his early experiments in the Isle of Wight, at Poldhu, Clifden and in America, on October 25, aged seventy.

Prof. Henryk Hoyer, emeritus professor of comparative anatomy of the Jagiellonian University, Cracow, widely known by his work on the comparative anatomy of blood and lymph vessels of vertebrates, on October 17, aged eighty-three.

Sir Leonard Pearce, C.B.E., engineer-in-chief to the London Power Company, who was responsible for the engineering design of the Battersea Power Station, on October 20, aged seventy-four.

NEWS and VIEWS

The Royal Wedding

Since attaining her twenty-first birthday in April of this year, during the tour of the Royal Family in South Africa, Princess Elizabeth has been taking a prominent part in many public functions. Thus apart from the general affection among the public which has been inspired by the sympathetic understanding and devotion to duty of the Royal Family, the people at large have had increased opportunities of learning to know Princess Elizabeth. In these pages it is appropriate to refer particularly to her association with, and interest in, scientific and similar bodies. Early this year, she was elected an honorary member of the Institution of Civil Engineers, and shortly afterwards she became a Royal fellow of the Royal Society. She has also accepted the office of president of the Royal Society of Arts, the activities of which were of deep concern to Prince Albert and in memory of whom the Society's premier award, the Albert Medal, was founded. In her address from the chair at the opening meeting of the present session of the Society, she stressed the importance of design, not only from the point of view of usefulness, but also from that of æsthetics. The industrial revolution, she said, had left a legacy of squalor, misery and ugliness, which was followed by a fall in standards of taste accompanying mass production methods. It is our duty to lead the world in finding a remedy and "to establish that beauty is as essential to utility as it proverbially is to truth". Scientific workers will wish to be associated with the good wishes which are being conveyed to Princess Elizabeth and Lieut. Philip Mountbatten from every part of the world on the occasion of their marriage.

Scientific Adviser to the Ministry of Food: Dr. N. C. Wright

Dr. N. C. Wright, director since 1928 of the Hannah Dairy Research Institute, Ayr, has recently been appointed to succeed Sir Jack Drummond as scientific adviser to the Ministry of Food, being seconded during the period of this appointment from the directorship of the Institute. Dr. Wright is a graduate of Oxford, and during his post-graduate training, carried out research in biochemistry at Cambridge, at the National Institute for Research in Dairying, Shinfield, and in the United States, where he held a Commonwealth Fund Fellowship during 1926–28. While at Shinfield, he investigated, with Mr. W. L. Little, the etiology of milk fever in cattle. These investigators were the first to point out the fall in blood calcium accompanying this disease, a discovery which laid the foundation for the modern method of treatment. Dr. Wright was appointed first director of the Hannah Institute in 1928, and the noteworthy progress of that Institute has been largely due to his efforts. He and his collaborators have, among other researches, examined the influence of heat on the behaviour of milk proteins, the mechanism of the secretion of calcium, phosphorus and other milk constituents by the mammary gland, the differences in biological value for milk secretion of various mixtures of food proteins in common use in the rations of dairy cows, and they have made valuable contributions to knowledge in each of these fields.

Dr. Wright has also in recent years studied the questions, at present of great national importance, of the feeding-stuffs requirement of farm animals in relation to home and overseas supplies, and the rival claims, under war-time conditions in Britain, of animals and man for food. His appointment at the Ministry coincides in time with the agricultural expansion programme for greater home production of food, a programme which largely depends for its implementation on the increased importation from overseas of animal feeding stuffs. Dr. Wright's recent studies will doubtless be of especial value in relation to this importation, which is a function of the Ministry of Food. Since 1936 he has paid several advisory visits overseas: to India, the Middle East, Ceylon, and recently to Greece with a mission of the United Nations Food and Agriculture Organisation, mainly in connexion with food production and livestock problems.

Discovery of Chloroform Anæsthesia

The discovery of the use of chloroform as an anæsthetic, made by Sir James Young Simpson in Edinburgh in 1847, was marked by a graduation ceremony at the University at which the honorary degree of LL.D. was conferred on Dr. H. W. Featherstone, founder-president of the Association of Anæsthetists of Great Britain, and Mr. T. B. Simpson, a grand-nephew of Simpson. A meeting to discuss the present-day use of chloroform was also held, at which Prof. R. R. Macintosh (Oxford) and Drs. D. S. Middleton and John Gilles (Edinburgh) read papers. Dr. Douglas Guthrie, lecturer on the history of medicine in the University of Edinburgh, gave an address at a reception in the Upper Library, where an exhibition of Simpson relics had been arranged. Dr. Guthrie said that the discovery of chloroform anæsthesia was one of the most dramatic episodes in the history of medicine, and with antiseptics had revolutionized surgery; it was remarkable that it had been delayed until the middle of last century. After graduating M.D. at Edinburgh in 1832, Simpson became assistant to Prof. John Thomson, professor of pathology, who advised him to specialize in midwifery. He was appointed professor of midwifery in the University in 1840, a post which he held until his death at the early age of fifty-nine in 1870. Since the discovery by Simpson of the anæsthetic properties of chloroform, there have been great advances in the technique of its administration, to which he himself contributed; and in spite of the introduction of many new substances, it still holds its place as a general anæsthetic.

Carl Friedländer (1847–87)

Friedländer's name is familiar to every medical student through 'Friedländer's bacillus', which, he described in 1882. A capsulated micrococcus, this is not now considered pathogenic for true lobar pneumonia, though it may cause the accompanying septicæmia. A native of Brieg in Silesia, Carl Friedländer was born a century ago on November 19, 1847. After taking the M.D. at the University of Berlin, he became assistant to Friedrich von Recklinghausen at Strassburg in 1874, and five years later was appointed to the modest post of assistant superintendent of post-mortem examinations in the Friedrichshain Hospital, Berlin. The courtesy title of professor was conferred on him only a few months before his death. Founder-editor of the *Fortschritte der Medicin*, Friedländer brought that journal to the front rank of German scientific periodicals. Among his most original work may be mentioned his description of thromboangiitis obliterans and his recognition of the tuberculous nature of lupus. He himself was a victim of pulmonary tuberculosis, which first manifested itself about 1882. His "Mikroskopische Technik" was a manual valued by student and expert alike.

Dr. Charles Creighton (1847–1927)

Founder of modern British epidemiology, Charles Creighton, who was born on November 21, 1847, towered above his fellows yet partook of their foibles and frailties. After obtaining the M.D. at Aberdeen in 1878 and studying in Berlin and Vienna, he practised for a time in London, but his heart was never in his work. He practically lived in the British Museum, where he collected material for his "History of Epidemics in Britain" (1891–94), described by Garrison as a "classic of unimpeachable accuracy". To the gigantic task of translating unaided Hirsch's "Handbuch der historisch-geographischen Pathologie" for the New Sydenham Society he devoted twelve hours a day for three years. He was the most learned British medical scholar of the nineteenth century, who stood for something fundamental in the intellectual world of his generation. He was handicapped, however, by a curious mental obliquity which forced him to believe that the generally accepted must be necessarily false. Incapable of sharing much of the current medical teaching and frequently clashing with his medical colleagues, he brought matters to a head when in his article on vaccination in the "Encyclopædia Britannica" he declared that cowpox had nothing to do with smallpox, affording no protection against it. This was acclaimed by the antivaccinators, and Creighton was ostracized by the medical profession. He spent his last years in philosophical isolation in a tumble-down cottage at Upper Boddington, turning to Shakespeare for solace. His slender means were amplified by a Civil List pension secured for him by Mr. Asquith, who admired his learning.

Hop Research in Britain

A new research centre has been set up for hop production problems. It is situated at Wye College, Kent, and is to be administered by the College. The Ministry of Agriculture, the Hops Marketing Board and the Institute of Brewing will provide grants to meet the costs of maintenance, and the two last-named will bear the capital costs of establishing the centre. Scientific advice on the programme of work of the new centre and the staff necessary to carry out that programme will be given by the Agricultural Research Council; to assist on technical matters, the Council has a Committee on Hop Research, on which there are members nominated by the grant-making bodies. The investigations at the new centre will include those concerned with soils, cultivation, varieties, breeding, diseases, brewing qualities and storage, and there will be close co-operation with investigations on hop diseases carried out at the East Malling Research Station or elsewhere.

Atomic Energy Train Exhibition

The atomic energy exhibition, organised by the Atomic Scientists' Association, was launched on November 6 at Liverpool by Sir James Chadwick. Speaking of the purpose of the exhibition, Sir James remarked that the excursion of scientific workers from the lecture room and the laboratory into the hurly-burly of public life was forced upon them by the urgency of the situation. Sooner or later the countries of the world will have to come to a decision about atomic energy, the trend of its development and the use to which it is to be put. This decision will have an important effect on the relations between nations and on the establishment of goodwill and confidence between them. In order to come to a wise decision it is necessary that the people at large should understand the fundamental facts. It is one of the aims of the Atomic Scientists' Association to explain to the public the facts about atomic energy. The main feature of the exhibition is the inclusion of experiments of the same type that are used in the laboratory. The first of the two coaches deals with the fundamental facts about atomic energy, and in it several Geiger counters are employed in order to demonstrate radioactive phenomena. The production of artificial radioactivity in silver by bombardment with slow neutrons is also demonstrated. The second coach deals with the practical applications of atomic energy, and it starts with a demonstration of the detection of fission in uranium. The gas diffusion, thermal diffusion and electromagnetic methods of isotope separation are all demonstrated on working models. The application of radioactive elements to medicine is illustrated on a film. All experiments are arranged to run automatically, but a member of the Atomic Scientists' Association is in attendance to give additional explanations.

The exhibition was first open to the public in Chester on November 10. It went from there to Stoke, and its further itinerary includes Manchester, Blackpool, Carlisle, Glasgow, Dundee, Aberdeen, Edinburgh, Newcastle, Middlesbrough, York, Leeds, Sheffield, Derby, Coventry, Nottingham, Leicester, Birmingham, Shrewsbury, Swansea, Bristol, Cardiff, Oxford, Reading and London. Efforts are being made to extend the duration of the exhibition to enable it to visit more places in the south of England. Inquiries about the exhibition should be addressed to Dr. J. Rotblat, Physics Department, University of Liverpool.

Starch Hydrolysis by Polarized Light

It has earlier been reported that exposure to polarized light induces hydrolysis of starch both *in vitro* and in the mesophyll of leaves. Now Dr. Elizabeth S. Semmens (*Plant Physiology*, 22, 270–278; 1947) describes experiments on the effect of polarized light on the starch content of stomatal guard cells. With a variety of plants and using both detached strips of epidermis and whole leaves attached to the parent plants, polarized light induces starch hydrolysis in the guard cells of the stomata; and this hydrolysis is accompanied by stomatal opening. Although in some cases the periods of exposure that preceded the observations were somewhat prolonged, these effects were also found when the period of exposure was only a few hours. With polarized direct sunlight the starch hydrolysis proceeded more vigorously, and bursting of the guard cells sometimes occurred. Although it appears likely that these observations, regarded as preliminary by the author, may, when extended, make a contribution to our knowledge of the vexed problem of stomatal mechanisms, their precise significance is at present difficult to assess.

Dominion Observatory, Wellington

The annual report for the year 1944 of the Dominion Observatory, Wellington, N.Z., shows that there was a general decline in seismic activity as compared with previous years. There was some concentration of activity south of Lake Taupo, but the intensity anywhere did not exceed V + on the modified Mercalli scale and the shocks were not destructive. Sixty-one tremors were felt in the North Island, forty in the South Island and six in both. The Jaggar seismograph at Hastings was in operation again by July and the seismographs at Auckland, Arapuni, Tuai, New Plymouth, Bunnythorpe, Wellington, Takaka, Kaimata, Christchurch and Monowai were recording throughout the year. The death occurred on May 24, 1944, of Mr. A. W. Burrell of Stratford, who for some time operated a Jaggar seismograph for the Department of Scientific and Industrial Research in the Dominion.

National Museums of Ceylon

This Director's report for 1945 (published 1946) on the national museums of Ceylon includes the Colombo, Kandy, Ratnapura, Jaffna and Navala Museums. All have suffered, in varying degrees, the difficulties associated with requisition, evacuation, or other war-time contingency, and in some cases results have been serious. The present report, however, shows that these institutions are now returning to their normal peace-time activities. From the Colombo Museum, for example, it is reported that the important work on the Museum's collections in relation to Ceylon's extinct mammals, living fauna, prehistory and certain antiquities, was resumed and the results published during the year. Damage and losses are still being assessed in this Museum, and the Jaffna Museum reports that only a very small part of the Twynam collections (stored in the Old Dutch Church) will be fit for exhibition again. Lists of acquisitions in respect of each museum are given in detail.

Anthropological and Archæological Work in India

The *Journal of the Indian Anthropological Institute*, vol. 1 (New Series), 1945, contains a number of interesting articles. Desiccation of Asia and its effect on human occupation is discussed by the late Sir Aurel Stein. Colonel Gordon surveys ancient Gandhara, and also describes some rock engravings and microliths in the Bangalore area. Colonel Gordon has long ago shown that most of the rock-shelter paintings and the rock carvings in India cannot be of any considerable antiquity. Nevertheless, such finds are of great interest, even if not very ancient. There are also papers on megalithic monuments of southern India by A. Aiyappan, and on Gond exogamy by M. P. Buradkar.

French Scientific Library in London

A small French scientific library is being built up at the Institut Français du Royaume-Uni, London. Both books and periodicals can be borrowed by post. In addition, microfilms of articles appearing in periodicals not available in the library can be obtained from France. These can either be consulted in the library, where a microfilm reader has been installed, or borrowed by post. All the library services are provided free. A catalogue of the books and periodicals available can be obtained from the Librarian, Scientific Library, Institut Français du Royaume-Uni, Queensberry Place, South Kensington, London, S.W.7.

Institution of Civil Engineers: Council for 1947–48

The Council for 1947–48 of the Institution of Civil Engineers is as follows: *President:* Sir Roger Hetherington; *Vice-Presidents:* Sir Reginald Stradling, Sir Jonathan Davidson, W. H. Morgan, V. A. M. Robertson; *Other Members of Council:* H. E. Aldington, Sir Stanley Angwin, Prof. J. F. Baker, G. Baxter, D. B. Brow (India), W. S. Cameron, F. M. Corkill (New Zealand), H. F. Cronin, Sir Arthur Dean (India), Dr. W. H. Glanville, A. Gray (Canada), Dr. E. J. Hamlin (South Africa), A. C. Hartley, G. H. Humphreys, Sir Claude Inglis, L. Leighton, H. J. B. Manzoni, M. S. Moore (Australia), Prof. A. J. S. Pippard, A. S. Quartermaine, J. C. L. Train, W. K. Wallace, Sir Arthur Whitaker; *Past-Presidents:* Dr. D. Anderson, F. E. Wentworth-Sheilds, Sir Peirson Frank, Sir William Halcrow; *Secretary:* E. Graham Clark.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A New Technique for Studying the Helium Film

In previous experiments the properties of the helium film and the mechanism of the transport in this film have been investigated systematically[1]. However, all these measurements were carried out with the bulk liquid present, and the film was therefore always under the vapour pressure of the latter. We have now developed a technique which permits the study of the film in equilibrium with the gas phase only, thus reducing the observations to the simpler case of a two-phase (film-gas) equilibrium. Use is made of the frictionless flow of the film through capillary leaks below the λ-point.

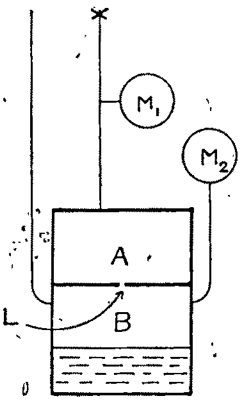

Fig. 1

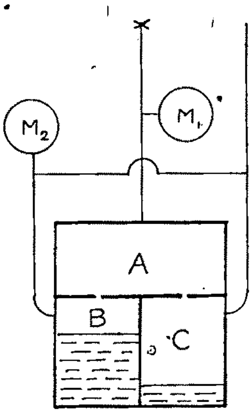

Fig. 2

Two containers, A and B (Fig. 1), the latter containing liquid helium I, are connected by the capillary leak L. If A is evacuated and then closed off, helium *gas* will leak from B through L into A, the rise of pressure in A being measured by the gauge M_1. When the liquid helium in B is cooled below the λ-point, however, a new process makes its appearance. Helium in the form of the transfer film now runs up the sides of B and passes over the perimeter of L into A, thereby constituting an additional leakage. By using progressively smaller capillary leaks, the stage can be reached where the gas leakage becomes insignificant compared with the film leakage, and it is then possible to study the film in A under varying gas pressures independent of the vapour pressure of the liquid. Tubes containing closely packed wires such as used by Allen and Misener[2] in their work on the viscosity of the bulk liquid were found to provide suitable capillary leaks.

The first experiments undertaken were determinations of the equilibrium pressure which will be set up in A through film leakage from B; that is, the vapour pressure of the film. However; some of the results obtained at first sight appeared quite paradoxical. In a number of experiments, the pressure in A rose not only to the value of the vapour pressure in B, which was measured independently on the gauge M_2, but surpassed it, settling at a higher value. The reason for this curious behaviour was indicated when it was found that in these cases, owing to the heat influx from outside, the container A was slightly warmer than the liquid in B. By purposely increasi the temperature of A, it could be made to fill up an equilibrium pressure more than twice as high the vapour pressure in B. Daunt and Mendelssoh have found that there exists a thermo-mechani effect in films similar to the fountain effect in t bulk liquid[3], and it would seem that in the prese case helium is transferred by the film to a regi of higher temperature and consequently high vapour pressure. This observation raises the intere ing question (to be settled by further experimen as to whether under these conditions the helium in will appear in the form of bulk liquid, and wheth there exists a temperature gradient in the trans film itself.

The new technique of studying the helium film c be applied to a wide range of problems. For examp by introducing a second capillary leak (Fig. 2) leadi into a third container C, which is also filled wi liquid helium II, but at a lower liquid level th that in B, the transfer of liquid by means of the fi from B through A into C can be studied. Prelimina experiments have shown that the transfer persi even when the pressure in A is reduced below t vapour pressure of the bulk helium. Other expe ments under way concern the actual temperatu of the film under various conditions and the spe of heat impulses along the film with the gas pha completely excluded. We are indebted to Dr. D. K. MacDonald for help during the experiments.

J. B. Brown
K. Mendelssohn

Clarendon Laboratory,
Oxford.
Aug. 13.

[1] Daunt and Mendelssohn, *Proc. Roy. Soc.*, A, 170, 423 (1939); *Natu* 143, 719 (1939); 157, 839 (1946).

[2] Allen and Misener, *Proc. Roy. Soc.*, A, 172, 467 (1939).

[3] Allen and Jones, *Nature*, 141, 243 (1938).

Electron Density in Meteor Trails

Contemporary studies of the radio echoes fro meteors indicate that dense transient concentratio of electrons are produced by the meteors at heigh of 90–120 km. above the earth's surface[1,2] Eckersley[4] calculated the intensity of scatter radio waves by assuming that the electrons we produced in a small cloud, and Pierce[5] by assumi that the electrons were produced in a long colum of diameter *large* compared with the wave-length the radio wave.

Recent experimental work on higher frequenci in the region of 60–70 Mc./s. has shown that the ma radio echo is obtained only when the aerial beam directed at right angles to the track of the meteor[1] This effect can be explained if the ionization is in t form of a long column, of diameter *small* compar with the wave-length of the incident radio wave. T intensity of a radio wave scattered from such a lo narrow column of ionization in the atmosphere, assu ing that the electrons scatter coherently, has be calculated by Blackett and Lovell[6], and in terms the parameters of the radio apparatus it can be show that if α is the number of electrons per cm. pat formed by the meteor and ε is the power scatter back to the receiver when the aerial beam is direct at right angles to the direction of the trail, then

$$\alpha = \sqrt{24\,\pi}\left(\frac{mc^2}{e^2}\right)\frac{1}{G}\sqrt{\frac{\varepsilon R^3}{P\lambda^3}},$$

where (mc^2/e^2) is the inverse of the classical electron radius, G is power gain of transmitter and receiving aerials over a half-wave dipole (assumed the same), R is distance of meteor trail from the apparatus, P is peak transmitter power, λ is wave-length of apparatus.

The validity of this formula has recently been tested experimentally as regards the predicted variation of received power ε with λ for a given meteor trail. During the Perseid meteor shower of August 1947, simultaneous observations of radio echoes from the same meteor trail were made on frequencies of 72 and 36 Mc./s. and also on 72 and 46 Mc./s. The experiment on 72 and 36 Mc./s. was repeated during a continuous 24-hour watch on September 23–24. For each pair of coincident echoes R and α will be the same, and if G and P are the same for the two equipments, the formula predicts that the ratio of the received powers ε_1 and ε_2 on two wave-lengths λ_1 and λ_2 will be $\varepsilon_1/\varepsilon_2 = (\lambda_1/\lambda_2)^3$. In the actual experiment the quantity measured is the amplitude of the echo on the cathode ray tube display, which can be converted to equivalent voltage input at the aerial by appropriate calibration of the receiver. If the two observed voltages are v_1 and v_2, then

$$\frac{v_1}{v_2} = \sqrt{\frac{\varepsilon_1}{\varepsilon_2}} = \left(\frac{\lambda_1}{\lambda_2}\right)^n,$$

and the theory predicts that the exponent n is 1·5.

107 coincident pairs of echoes were measured with $\lambda_1 = 8{\cdot}3$ m., $\lambda_2 = 4{\cdot}15$ m., and 57 coincident pairs with $\lambda_1 = 6{\cdot}5$ m., $\lambda_2 = 4{\cdot}15$ m., between August 12 and 27. On September 23–24 a further 160 pairs were measured with $\lambda_1 = 8{\cdot}3$ m., $\lambda_2 = 4{\cdot}15$ m. From the measured values of v_1 and v_2, the exponent n has been calculated for each pair and the results are summarized in the accompanying table.

	Number of observations	Number of observations used in calculation	Ratio $\frac{\lambda_1}{\lambda_2}$	Mean value of measured voltage ratio $\left(\frac{v_1}{v_2}\right)$	Mean value of exponent n	Standard deviation
Aug. 12–27 :						
Simultaneous observations on 36 and 72 Mc./s.	107	74	2·0	2·6	1·4	0·5
Simultaneous observations on 46 and 72 Mc./s.	57	38	1·56	2·2	1·8	0·5
Sept. 23–24 :						
Simultaneous observations on 36 and 72 Mc./s.	160	135	2·0	2·4	1·3	0·5

The observed voltages v_1 and v_2 used in these results have been corrected for the differences in peak power P between the three equipments. The main error in the experiment lies in the assumption that the aerial gain G is the same. Although geometrically similar aerial systems were used on the three wave-lengths, slight differences of terrain and surroundings inevitably introduce variations in the polar diagrams of the aerials. It can therefore be anticipated that a certain number of meteor trails will form in regions where the polar diagrams of the two comparison equipments are not exactly similar, and hence give rise to a considerable scatter of the results about the mean value. In deriving the results given in the table, coincident pairs showing deviations from the mean exponent greater than three times the average deviation have been rejected.

The results are in reasonable agreement with the predicted relation between ε and λ, and although more experiments are needed to establish the exact relationships, it now seems plausible to assume that the fundamental assumptions made in deriving the formula are not seriously in error for radio wave frequencies in the 30–70 Mc./s. region.

By using this formula it is possible to calculate the electron density in meteor trails, since G, P and λ are constants of the apparatus and ε and R are measured for individual echoes. The densities measured (with $G = 4$, $P = 70$ kW., $\lambda = 4{\cdot}15$ m.) lie in the range 10^{10}–10^{12} electrons per centimetre of path. Triple simultaneous observations of meteors on the two equipments and visually were also made during this experiment. These results show that a 5th magnitude meteor which is near the limit of naked eye visibility produces about 2×10^{10} electrons per centimetre of path. These results for electron densities lie in the same region as those found by combined visual and radio echo measurements on the 1946 Perseid shower[2].

These experiments were made at the Jodrell Bank Experimental Station of the University of Manchester in conjunction with J. A. Clegg, J. G. Davies, C. D. Ellyett and V. A. Hughes.

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[1] Hey and Stewart, *Nature*, **158**, 481 (1946), and *Proc. Phys. Soc.*, **59**, 858 (1947).

[2] Prentice, Lovell and Banwell, *Mon. Not. Roy. Ast. Soc.* (in the press). Lovell, Banwell and Clegg, *Mon. Not. Roy. Ast. Soc.* (in the press).

[3] Appleton and Naismith, *Proc. Phys. Soc.*, **59**, 461 (1947).

[4] Eckersley, *J. Inst. Elect. Eng.*, **71**, 405 (1932).

[5] Pierce, *Proc. Inst. Rad. Eng.*, **26**, 892 (1938).

[6] Blackett and Lovell, *Proc. Roy. Soc.*, A, **177**, 183 (1941).

[7] Lovell, in publication.

A New Technique for Following the Attack of Metallic Mirrors by Free Radicals

THE removal of metallic mirrors is a well-established technique for the detection and identification of free radicals produced in the decomposition of organic compounds. The rate of removal of mirrors is usually followed by photometric means, in which the opacity of the mirror is matched against that of a standard. In the course of an investigation into the attack of free radicals on coal and coal by-products at high temperatures, it was found that the evolution of smoke and tarry material tended to make the use of optical methods somewhat unreliable. It was thought that measurement of the electrical conductivity of mirrors could be applied to the problem and, in particular, glass elements of the type used in the measurement of the dewpoint of combustion gases containing sulphur oxides[1] seemed to be ideal for this purpose.

The elements used have been described in detail by Dooley and Whittingham and consist of a 'Pyrex' tube closed at one end into which two platinum–platinum-rhodium thermocouples are fused. The convex surface is carefully polished so that the thermocouples lie correctly in the surface, and a known potential is applied across the gap, the current passing being measured on a micro-ammeter.

The temperature of the surface can be accurately recorded, and the deposition and removal of extremely thin metallic mirrors is reflected in changes in the electrical conductivity across the gap between the thermocouples. The use of this technique can best be illustrated by reference to some exploratory work carried out on the decomposition of lead tetraethyl.

The element was fitted with a ground-glass joint, to permit ease of removal, and was placed at one end of a long 'Pyrex' tube through which a rapid stream of oxygen-free nitrogen, at a pressure of 1–2 mm., was passed. The nitrogen was charged with lead tetra-ethyl vapour by passage through a trap, maintained at − 78° C., containing lead tetraethyl. The area of glass between the two thermocouples, approximately 0·5 sq. cm., was heated either by a small platinum spiral inserted inside the element, or by directing a stream of air through an electrically heated quartz tube on the underside of the element.

On heating the glass a slow increase in conductivity due to the production of a lead film was first observed at 180° C., and a more rapid build-up took place at 200–220° C. These temperatures are well below those at which the glass begins to exhibit conductivity. After the conductivity had increased to any desired value the source of heat was removed, and the element allowed to cool to room temperature. The tube through which the nitrogen – lead ethyl mixture passed was then heated at different distances from the element, and the accompanying table gives values obtained for the time of removal of the mirror (θ) at a distance d from the point at which the ethyl radicals are produced. The streaming velocity of the gases was 11 metres per sec. and the life of the radical (t) is therefore $d/1{,}100$ sec.

Distance, d, in cm.	Life, t, in sec.	Removal time, θ, in sec.	$\log_{10} 1/\theta$
4	$3\cdot6 \times 10^{-3}$	26	$\bar{2}\cdot5850$
8	$7\cdot2$	31	$\bar{2}\cdot5086$
12	$10\cdot9$	45	$\bar{2}\cdot3468$
18	$16\cdot4$	65	$\bar{2}\cdot1871$
28	$25\cdot4$	120	$\bar{3}\cdot9208$

From the plot of $\log_{10} 1/\theta$ against t the half-life period of the ethyl radicals was found to be $1\cdot4 \times 10^{-2}$ sec. No difficulty has been encountered either in depositing reproducible mirrors of a given thickness or in obtaining consistent times of removal.

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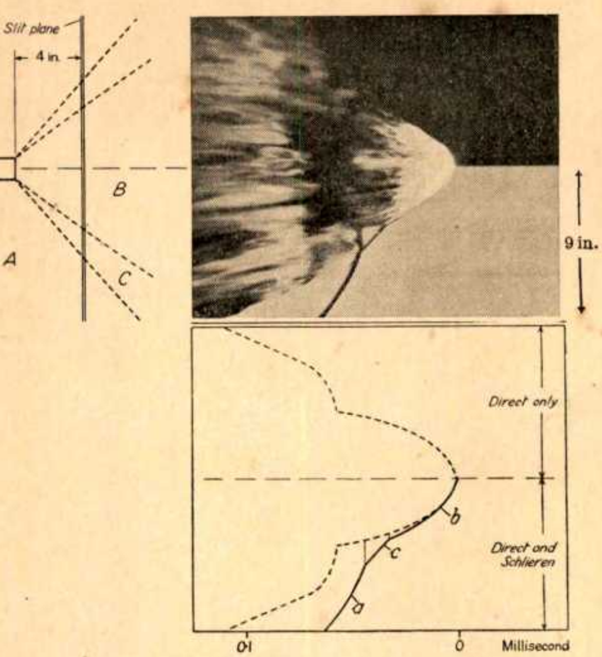
[1] Dooley, A., and Whittingham, G., *Trans. Farad. Soc.*, **42**, 354 (1946).

Mach Waves in Shock Wave Systems from Detonating Explosives

WE have recently obtained many photographs of Mach waves[1], known alternatively as 'bridge' or 'Y' waves[2], in the shock wave systems resulting from the detonation of unconfined charges of solid explosive. Waves of this type, which Mach postulated from the observation of soot patterns, are produced when supersonic waves intersect at obtuse angles of incidence. Instead of the simple intersection (which obtains in collisions at acute angles as well as in collisions of sonic waves at any angle of incidence), there is formed a Mach wave which travels in a direction parallel to the plane of symmetry bisecting the angle between the original colliding shock waves.



The accompanying *Schlieren* photograph, taken with the Buxton rotating-mirror camera, depicts the development of the flame and shock wave system in a plane 4 in. beyond the end and at right angles to the axis of a right cylinder of cast 30 : 70–tetryl/T.N.T., 1¼ in. in diameter (velocity of detonation 7,030 m./sec.). The diagram to the left of the photograph indicates the position of the charge with respect to the camera slit. The lettered diagram below the record shows a lateral wave a, a terminal wave b and an intermediate wave c, all in full line; the broken line represents the boundary of the products of the detonation. Waves a and b arise in a way previously proposed[3], a during the passage of the detonation wave along the charge, and b from the detonation of the ultimate layers of explosive. The impulses are directed, one very nearly in the equatorial plane and the other along the axis; wave c is a Mach wave arising from the progressive collision of a and b at sufficiently oblique incidence.

From plottings of the linkage points of c with a and with b as measured on records of the shock wave system in different planes, curves can be derived which outline a widening annular region swept out by the Mach wave c. The section of this region is a funnel with smooth boundaries which curve towards the axis, the inner more so than the outer. The position of the funnel C is shown in the diagram to the left of the photograph, the regions marked A and B being those traversed by the waves a and b respectively. As expected, the funnel is generated from the circular periphery of the plane end of the explosive, and its initial direction coincides approximately with the external bisector of the angle between the two intersecting surfaces, that is, at about 45° to the axis in the simple case of the right cylinder. The shape of the Mach funnel and its direction depend, however, on the shape of the charge; for example, a circular Mach wave (as distinct from the above annular type) is generated from the point of a cone, provided that the apical angle is less than about 135°. In similar fashion, it is found that Mach-type discontinuities link the lateral waves from adjacent surfaces of a square prism of explosive.

These photographic experiments have been carried out for the Ministry of Supply, and approval for the publication of this note has been given by the Chief Scientist.

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June 21.

[1] Mach, *Sitz. (Wiener) Akad. Wissenschaften*, 77, 819 (1878).

[2] McMillen and Harvey, *J. Appl. Phys.*, 17, 541 (1946).

[3] Payman and Woodhead, *Proc. Roy. Soc.*, A, 163, 575 (1937).

The 'Floating Thread', a Surface Phenomenon on Flowing Water

IN 1936, W. Schmidt[1] described the following phenomenon. When the surface of slowly moving water encounters an obstacle (such as a stick put across a brook and upon its surface), a tiny elevation of the surface is formed at a distance of some decimetres or metres before the obstacle, "appearing like a very fine thread or hair floating on the surface". "Minute floating particles crossing the thread are abruptly retarded and thus accumulate." "That capillary forces are largely responsible for the phenomenon is proved by pouring a liquid of lower surface tension like liquid paraffin over the surface, when the thread is at once displaced upstream by several metres." Schmidt offers no detailed explanation of the phenomenon, and, so far as I know, nothing else was published about the matter.

The surface between the thread (which is perpendicular to the direction of flow) and the obstacle being motionless, the shearing force being in equilibrium with the gradient of surface tension:

$$\mu\left(\frac{\partial v_x}{\partial y}\right)_{y=0} + \frac{d\sigma}{dx} = 0$$

(where y is depth, and velocity of undisturbed flow is $(-v_0, 0)$). The solution of Oseen's equation for the flow along a rigid half-plane[2] gives an approximate formula for the shearing velocity:

$$\left(\frac{\partial v_x}{\partial y}\right)_{\substack{y=0\\x<0}} = -\sqrt{\frac{\rho v_0^3}{-\pi\mu x}}$$

(the half-plane covers the negative x-axis). Whereas the tension of the free-flowing part of the surface upstream of the thread ($x > 0$) has a constant value ($\sigma = \sigma_0$), on the downstream side the tension falls towards the obstacle:

$$\sigma = \sigma_0 - 2\sqrt{\frac{-\rho\mu v_0^3 x}{\pi}}.$$

Thus the distance (d) between the thread and the obstacle is determined with the minimum surface tension (σ_1) which can be attained with the present quantity of capillary-active substance:

$$d = \frac{x(\sigma_0 - \sigma_1)^2}{4\mu\rho v_0^3};$$

in the case of turbulence, that is, at $\rho v_0 d/\mu > 500{,}000$, the formula gives values which are too large.

The hydrodynamic problem was solved by assuming the surface to be plane. A constant value of the pressure (equal to the atmospheric pressure p_0) was found only at the downstream part of the surface, while at the upstream part the calculation gives the difference $p - p_0 = \sqrt{\frac{\rho\mu v_0^3}{\pi x}}$. An approximation for the real shape of the surface, $y = y(x)$, can be obtained by putting the calculated pressure-difference into the equation for the equilibrium between pressure-, gravity- and capillarity-forces:

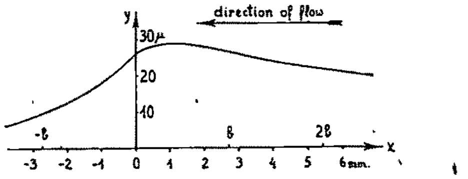
$$\sigma\frac{d^2y}{dx^2} - \rho g y = \begin{cases} 0 \ldots\ldots\ldots\ldots x < 0 \\ \sqrt{\dfrac{\rho\mu v_0^3}{\pi x}} \ldots\ldots x > 0 \end{cases}$$

y and dy/dx must both be continuous at $x = 0$, whereas d^2x/dx^2 becomes infinite at the upstream side. Neglecting now the inconstancy of the surface tension on the downstream side, we get the approximate result:

$$y = \frac{\lambda}{2g}\sqrt{\frac{\mu v_0^3}{\rho b}} \cdot \exp\frac{x}{b} \ldots\ldots x < 0.$$

$$y = \frac{\lambda}{2g}\sqrt{\frac{\mu v_0^3}{\rho b}} \cdot \frac{\lambda}{\sqrt{\pi}} \int_0^\infty \frac{\left(\exp - \left|\frac{x}{b} - \xi\right|\right)}{\sqrt{\xi}} d\xi \qquad \ldots\ldots x > 0.$$

The length $b = \sqrt{\sigma_0/\rho g}$ may serve as a measure of the width of the thread. The maximum elevation is at $x \doteq 0{\cdot}40\,b$; $y_{\max} = 1{\cdot}104y(0)$.



CROSS-SECTION OF THE FLOATING THREAD. THE HEIGHT IS EXAGGERATED 100 TIMES

A numerical example (see figure) may give an idea of the size of the phenomenon. Take $\sigma_0 =$ 70 dyne/cm., $\sigma_1 = 30$ dyne/cm., $\mu = 0{\cdot}01$ poise, $v_0 = 10$ cm./sec. It follows that $d = 126$ cm., $b = 0{\cdot}27$ cm., $y(0) = 0{\cdot}0026$ cm., $(dy/dx)_0 = 0{\cdot}01$ cm. Obviously the results justify the simplifications made above. Very rough preliminary observations seem to agree with the suggested theory (measurements are in progress). With a slight modification the same theory can help to describe the mechanism of spreading of capillary-active films on liquid surfaces, as first observed by Osborne Reynolds[3].

The discontinuity at the thread might seem to present a theoretical difficulty. The infinite curvature at $x = +0$ involves an infinite pressure below that point. Of course, the consideration of the diffusion of the capillary-active substance would have avoided that difficulty. But even without that, it is evident that large pressures do not appear at all; calculation shows that the interval in which the pressure difference would be comparable with the atmospheric pressure is of molecular order of size or smaller.

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[1] Schmidt, W., *Nature*, 137, 777 (1936).

[2] Compare with Lamb–Oseen's solution for the cylinder. See, for example, Müller, W., "Einführung in die Theorie der zähen Flüssigkeiten", 127 (Leipzig, 1932).

[3] See, for example, Adam, N. K., "The Physics and Chemistry of Surfaces", 212 (London, 1944).

Mechanical Degradation of Large Molecules

From the thermo-chemical data for the strength of the carbon-carbon single bond (about 5×10^{-3} dynes), the rate of shear was estimated for rupturing the centre bond of large hydrocarbon molecules in solution under laminar flow conditions owing to the component of the viscous drag in the direction of the long axis of the molecule. Experiments confirmed the calculated order of magnitude of the critical value of the rate of shear as a function of the chain-length of the molecule.

Table 1. Percentage permanent viscosity-loss at 20° C. with the number of passages of the liquid through the jet for a 5 per cent solution of a polymer having an average molecular weight above 100,000 with an initial mean rate of shear of $1 \cdot 75 \times 10^5$ sec.$^{-1}$

Apparent percentage permanent viscosity loss from (pt)-values*	Number of cycles through jet	Percentage permanent viscosity loss at low rates of shear	Viscosity-temperature coefficient
0	0	0	− 1·770
4·8	6		
6·3	7		
6·3	8		
7·8	9		
7·8	11		
7·9	12		
8·2	13		
10·0	18		
10·6	25		
11·1	28		
11·1	29		
11·3	30		
13·7	56		
13·8	70		
15·0	71		
13·9	72		
15·2	102		
15·3	103	8·8	− 1·877

* p = pressure difference across jet in cm. mercury, t = time of flow in seconds. The permanent decrease of the (pt)-values of very long molecules (length of the order of 1 per cent of the diameter of the jet) is always larger than the permanent viscosity-loss measured at low rates of shear because turbulence arises with these long molecules even at very low Reynolds' numbers. With the degradation of the molecules this tendency to turbulence becomes reduced.

With an apparatus[1] giving mean rates of shear of the order of 10^5 sec.$^{-1}$ under laminar flow conditions, long-chain molecules of molecular weights above 100,000 were broken down (Table 1), yielding an exponential type of decay curve for the percentage permanent viscosity-loss plotted as a function of the number of cycles of forcing the solution in individual drops through a jet. The mechanical degradation was assessed by the *permanent* viscosity-loss of the solutions at low rates of shear, by the accompanying increase of the viscosity-temperature coefficient of the solutions and by the displacement of the transition region from laminar to turbulent flow towards higher values of the rate of shear as the result of rupturing the largest molecules.

According to the simplifying assumptions made for the calculations, the stretching forces reached their largest value for the centre chemical bond and would increase with the square of the length of the molecule for a given value of the shearing stress. Thus, rates of shear of more than $1 \cdot 6 \times 10^6$ sec.$^{-1}$ would be required for the breakdown of molecules of molecular weights of 25,000 and less.

Table 2. Percentage permanent viscosity-loss with the number of passages of the liquid through the jet for a 5 per cent solution of a polymer having an average molecular weight less than 25,000

Mean rate of shear in sec.$^{-1}$	Percentage permanent viscosity loss at low rate of shear and at 37·8° C.	Number of cycles	Viscosity-temperature coefficient
0	0	0	− 2·813
$3 \cdot 823 \times 10^6$	3·4	500	− 2·846
$3 \cdot 823 \times 10^6$	7·0	2500	− 2·882
$3 \cdot 823 \times 10^6$	9·2	5000	− 2·907
$6 \cdot 324 \times 10^6$	6·0	1000	− 2·885
$6 \cdot 324 \times 10^6$	12·3	5000	− 2·954
1×10^7	8·0	2000	− 2·912
1×10^7	13·0	5000	− 2·979

With a high-pressure jet (to be described elsewhere) calculated to give rates of shear of the order of 10^7 sec.$^{-1}$ for Poiseuille flow, materials of molecular weights of 25,000 and less which remained unaffected in the previous apparatus[1] for rates of shear of the order of 10^5 sec.$^{-1}$ were broken down (Table 2).

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[1] Morris, W. J., and Schnurmann, R., *Rev. Sci. Instr.*, 17, 17 (1946).

Christiansen Filters for the Ultra-Violet

Gaydon and Minkoff[1] have described a Christiansen filter designed to isolate the 2537 A. resonance line of mercury. We have been working for some time upon the general problem of the design of Christiansen filters for the isolation of various spark and discharge tube lines to be used in ultra-violet microscopy. We have amplified the work of Kohn and von Fragstein[2], and developed a series of filters employing benzene–alcohol mixtures with fused quartz chips, which can span the region 3000–4000 A.

The absorption of benzene prevents the use of this combination below 3000 A. Therefore, we have developed a set of filters employing mixtures of purified decahydronaphthalene and cyclohexane,

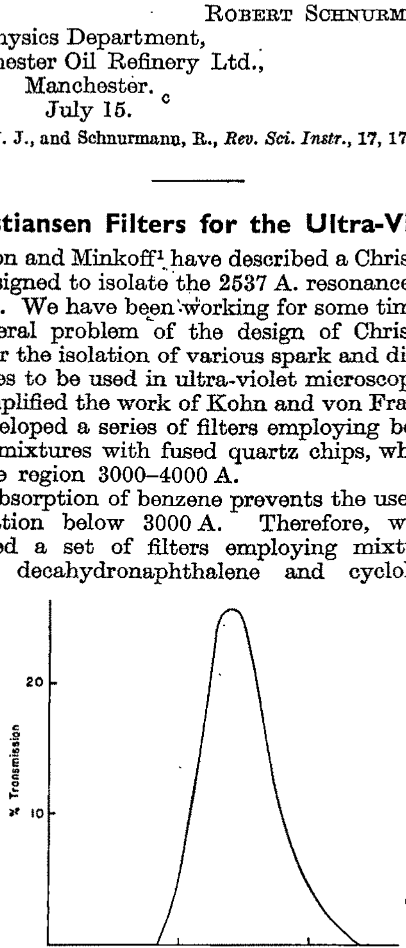

Fig. 1

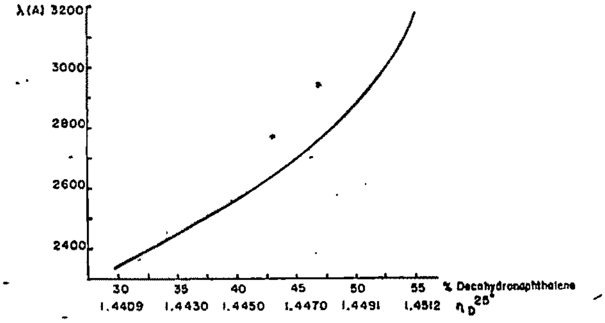

Fig. 2

which, with quartz chips, can be used in the region 2350–3000 A. The decahydronaphthalene and cyclohexane are purified by treatment with activated silica gel, either by passage through a column or by shaking with repeat charges. When thus purified, the cyclohexane in 1 cm. thickness will transmit, with a density less than 0·05, to 2250 A., the decahydronaphthalene to 2380 A.

A typical transmission curve for a filter designed to isolate the 2652 A. line of a medium-pressure mercury discharge tube is shown in Fig. 1. This filter employed quartz chips, graded between 0·6 and 0·8 mm., and was 5 cm. thick. The transmission curve was obtained on a small Hilger spectrograph. Fig. 2 indicates the composition of mixtures to provide filters giving a peak value at the wave-length indicated by the ordinate at 25° C. The $n_D^{25°}$ of the mixture is also given, as this is probably a more accurate indication of the correct mixture.

Above 3000 A., benzene–alcohol mixtures are to be preferred, as they provide filters of narrower band-width for the same thickness.

Studies are in progress as to the effect of particle size, optical parameters, etc., upon the peak transmission and band-width of these filters.

This work has been done in part under an American Cancer Society fellowship and grant recommended by the National Research Council Committee on Growth.

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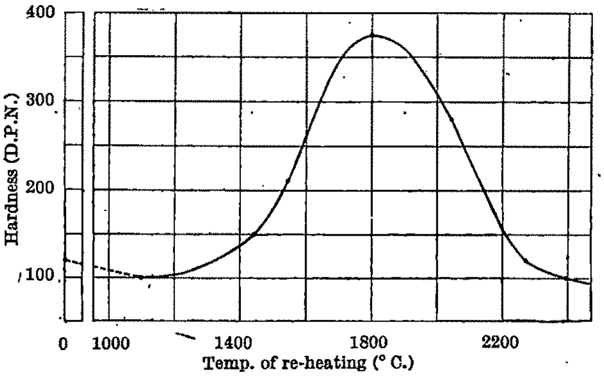
[1] Gaydon and Minkoff, *Nature*, 158, 788 (1946).

[2] Kohn and von Fragstein, *Phys. Z.*, 33, 929 (1932).

Annealing Temperature and Hardness of Tantalum

During experiments to determine the relationship between annealing temperature and hardness of tantalum after cold working, it was found that after a slight preliminary softening (temperatures up to 1,100° C.) the hardness rose steeply, reaching a maximum value after heating to 1,800° C., then falling again with higher temperatures.

The heating was carried out by passing a low-voltage current through the test piece in a vacuum of the order of 10^{-3}–10^{-4} mm. of mercury. When the current ceased to flow, the test piece cooled quickly by radiation. A typical curve is given in the accompanying figure.



The following points have been proved:

(*a*) Tantalum powder from three sources (American, Australian and German) compacted by pressing and sintering was cold worked (room temperature) by swaging and wire drawing and was quite ductile. On heating to 1,800° C. (as above) all materials became hard and brittle.

(*b*) The maximum value of hardness is found after heating to 1,800° C. irrespective of the initial amount of cold work.

(*c*) The hardness maximum appears to be a function of the initial amount of cold work, though no regular relationship has been found. The hardest material produced had a value 500 D.P.N.

(*d*) Hard tantalum becomes soft again if the heating is carried to 2,400° C. followed by quick cooling.

(*e*) Tantalum reheated to 2,400° C. and slowly cooled (7° C. per minute) to 1,100° C. is hard and brittle.

(*f*) X-ray diffraction patterns from tantalum in the soft and hard states indicate a body cubic structure in both cases. However, in the soft condition the lines are composed of distinct sharp spots, whereas in the hard state the lines are diffuse, and broader, and the spacing indicates an expanded lattice. No new lines were visible.

The most reasonable explanation of the above facts would appear to be that some gas molecules are absorbed even at the low pressure stated, and that these are held most tenaciously at 1,800° C. The increase in hardness of 300–400 units D.P.N. for such relatively low concentrations is, however, remarkable. The phenomenon is being further investigated.

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Tryptophane as Precursor of Nicotinamide in Mammals

Tryptophane can replace nicotinamide in the nutrition of the growing rat[1] and when ingested increases the urinary elimination of nicotinamide derivatives of mammals and man[2–6]. The site and mechanism of this conversion of tryptophane into nicotinamide are unknown and form the subject of this investigation.

Biosynthesis of nicotinamide may occur in the mammalian tissue[7] or in the intestinal flora[8–12]. Bacteria of the *coli* type seem to be mainly responsible for the synthesis[13,14]. To find out whether the tryptophane conversion takes place in the tissues or the intestinal flora, rats kept on a mixed diet received 100 mgm. of *d,l*-tryptophane at three-day intervals alternatively either orally or parenterally. The increase in urinary nicotinamide methochloride elimination proved to be two to five times greater after oral than after parenteral administration, which is in accordance with findings of Schweigert and Pearson[3]. In other rats similarly fed, the increase in urinary nicotinamide methochloride output following tryptophane ingestion was measured before and during the daily administration of 1 gm. succinylsulphathiazole, with simultaneous bacteriological control of the fæces. When the fæcal *coli* and the spontaneous nicotinamide methochloride output were considerably reduced the increase in nicotinamide methochloride elimination caused by 100 mgm. of *d,l*-tryptophane was reduced to a fifth to a half the original increase. The results of both groups of experiments demonstrate at least that the intestinal flora is involved in the tryptophane conversion.

Of the known metabolites of tryptophane, kynurenic acid[15], kynurenine[16] and xanthurenic acid[17], none is a probable precursor of nicotinamide, because the first is an α-carboxylic acid, and nicotinic acid is a β-carboxylic acid, and the two others are only sparingly formed in the non-deficient animal. The urinary output of nicotinamide derivatives could not be increased by the ingestion of kynurenic acid[18]. Only 25–30 per cent of ingested tryptophane is eliminated as these metabolites.

When considering another possible way of degradation, we thought of the hitherto unproved formation of ornithine by reductive splitting off of the pyrrole nucleus. Ornithine was suggested as basis of the biosynthesis of nicotinic acid by Guggenheim[19].

To investigate this question, 24-hr. cultures of two *coli* strains isolated from rat fæces and known to synthesize nicotinamide when grown in an ammonium lactate medium[20] were inoculated and grown in this medium containing various concentrations of the following amino-acids : *l*(+) ornithine, *l*(+) arginine, *d,l*-glutamine, *d,l*-glutamic acid, *l*(+) citrulline, *l*(+) proline, *l*(+) leucine, *l*(−) isoleucine, *d,l*-valine, and *d,l*-tryptophane. Concentrations of $M/1,500$ to $M/1,000$ of the amino-acids proved to be most efficient. After 24 hr. incubation, the cultures were autoclaved and the growth assayed by titrating the acid formed with $N/10$ sodium hydroxide. Nicotinamide formed was measured microbiologically using *Lactobacillus arabinosus* in Barton-Wright[21] medium as a test object. Controls showed that none of the amino-acids used affected the acid formation by *Lactobacillus arabinosus*. The growth was increased by about 30–70 per cent by leucine, isoleucine, valine, citrulline, glutamic acid and tryptophane, but not, or less than 10 per cent, by the others. The formation of nicotinamide was, however, increased up to 4½ times by ornithine, by 50–70 per cent by glutamine and arginine when compared with the synthesis of nicotinamide in the controls. Of the other amino-acids, proline and tryptophane did not affect the relative nicotinamide production, while the others inhibited it. By a simultaneous assay using a *Leuconostoc mesenteroides* strain (kindly supplied by Dr. B. C. Johnson of the University of Illinois) which was much less sensitive to nicotinamide than to nicotinic acid, it was found that the derivative formed by the *coli* was almost exclusively nicotinamide.

These results show that ornithine can be utilized *in vitro* for the biosynthesis of nicotinamide by *coli*, and that arginine and glutamine, also with amino-groups in the δ-position and which probably can be converted into ornithine, have a similar effect. Whether ornithine can be formed from tryptophane has still to be proved. The fact that tryptophane does not increase the nicotinamide production by *coli* under the conditions of the experiment might be due to the inability of the *coli* to perform the tryptophane degradation. Other intestinal bacteria might be able to do this. Experiments using a mixed culture from the contents of a rat's cæcum showed an increase of nicotinamide production when tryptophane was added. This needs further investigation.

Ingestion of ornithine by rats did not increase the nicotinamide methochloride output, which might be explained by the quick utilization of this compound for protein formation. Perhaps the use of some possible intermediary between ornithine and nicotinamide may elucidate this point.

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Composition and Structure of the Liver Cell in Pregnancy

It has been previously shown that the deoxyribonucleic acid content of the liver is independent of the protein content of the diet, while the protein, phospholipin and ribonucleic acid contents vary directly with the dietary protein intake[1].

Little is known regarding the changes occurring in the liver during pregnancy. Liver proteins are increased and more of the maternal protein is apportioned to the liver in pregnant rats than in non-pregnant controls[2]. The total nucleic acid content is considerably increased, both deoxyribonucleic acid and ribonucleic acid taking part in this rise[3].

It has now been found that in pregnant rats, during the third week of gestation, the deoxyribonucleic acid content of the liver (mgm. per liver) is considerably raised. Since the deoxyribonucleic acid content of the liver rises with increasing body weight, the changes in body weight during pregnancy have to be taken into account. The statistical analysis of the data (Dr. J. O. Irwin) shows that when adjusted for differences in maternal body weight (without fœtuses), the deoxyribonucleic acid content of the liver is significantly greater in pregnant than in non-pregnant rats, and, further, that the total quantity of deoxyribonucleic acid found in the liver during pregnancy closely corresponds to the sum of the maternal and fœtal body weights. This would signify that in pregnancy the liver has to fulfil its metabolic functions not only for the maternal body but also for the fœtuses. The rise in liver deoxyribonucleic acid is found in rats fed on the stock diet (group *A*), and in rats which had been fed on a protein-free diet for five days prior to the examination of the liver (group *B*).

The most remarkable of the changes occurring in the liver during pregnancy is, however, the rise in the ratio of ribonucleic to deoxyribonucleic acid. We found that this increased from 3·97 to 5·81 in group *A* (+46·5 per cent) and from 3·17 to 4·42 in group *B* (+ 39·5 per cent). It is known[1] that the changes in the ratio of ribonucleic to deoxyribonucleic acid due to variations in the dietary protein intake are accompanied by corresponding changes of approximately the same magnitude in the protein to deoxyribonucleic acid and phospholipin to deoxyribonucleic acid ratios. This also is true for pregnant rats; but in addition to the dietary variations of all three ratios, there is in pregnancy a specific rise in the ratio of ribonucleic to deoxyribonucleic acid, with inconsistent and relatively small changes in the other two ratios. Thus in group *A*, the protein to deoxyribonucleic acid ratio of the pregnant rats was only 9 per cent higher than that of the non-pregnant controls, while the phospholipin to deoxyribonucleic acid ratio did not change significantly; in group *B* there was no significant change in the protein to deoxyribonucleic acid ratio, while the phospholipin to deoxyribonucleic acid ratio rose by 21 per cent in the pregnant rats. The magnitude of the rise of the ratio of ribonucleic to deoxyribonucleic acid above the values found in non-pregnant controls is positively correlated with the weight of the uterine contents.

The presence of these large amounts of ribonucleic acid in the liver cell during pregnancy has its histological counterpart in a great increase in cytoplasmic basophilia. This is particularly well seen as diffuse basophilia in the periportal area and, by means of Brachet's ribonuclease test, has been proved to be caused by ribonucleic acid.

The glycogen content of the livers in both dietary groups is very much decreased during pregnancy.

We wish to thank Dr. J. O. Irwin, who kindly carried out the statistical analysis of the deoxyribonucleic acid data. We are also indebted to the Medical Research Council for grants for scientific assistance and expenses (to H. W. K.).

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Fluorescent Constituents of Liver Lipid Extracts

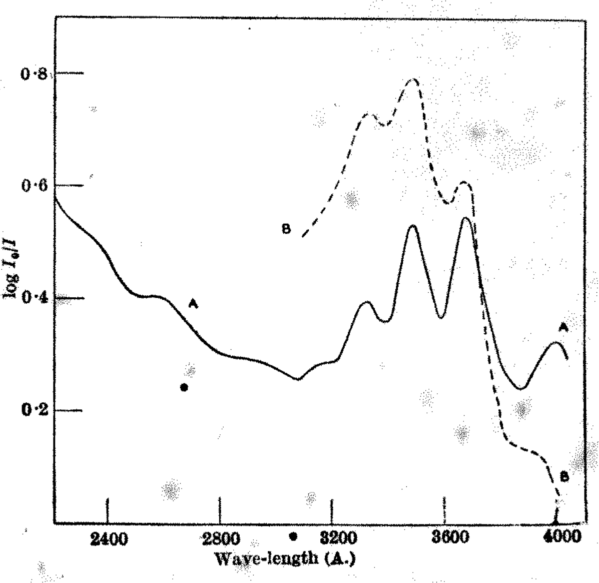
Penn and Kaplan[1] recently reported the preparation of concentrates exhibiting banded fluorescence spectra from acetone extracts of the livers of cancer patients. They have directed attention to the similarity between these spectra and the fluorescence spectrum of methylcholanthrene.

In continuation of earlier work[2], we have concentrated the fluorescent constituents of the non-saponifiable lipid-soluble material obtained from the livers of five cancerous and two non-cancerous individuals; but in none of our fractions have we been able to recognize any polynuclear aromatic hydrocarbons by ultra-violet spectrophotometry.

From two of the livers, fractions were obtained which possessed sharply banded absorption spectra between 3000 and 4000 A., and which exhibited an intense bluish-green fluorescence. The spectrum of one such fraction (Curve *A*) gave strong maxima at 3320, 3480 and 3680 A. in solution in *n*-heptane, together with a weaker maximum at 3990 A. The absence of intense absorption between 2000 and 3000 A. in curve *A* makes it improbable that these bands are associated with the presence of a condensed polynuclear aromatic hydrocarbon in the extract. The spectrum between 3200 and 3800 A. is closely similar to that reported by Zechmeister and Polgár[3] for material isolated from several plant sources, and tentatively identified by these investigators as iso-anhydro-vitamin A; the band at 3990 A. may be due to anhydro-vitamin A [4].

Iso-anhydro-vitamin A, prepared in our laboratory by the prolonged action of dry hydrogen chloride on a chloroform solution of vitamin A, gave the spectrum shown in Curve *B*, the location of the maxima being in good accord with those reported by Shantz, Cawley and Embree[4]. This product also exhibited a greenish-blue fluorescence, more stable and much more intense than that of vitamin A. Mixed with one of the fluorescent liver concentrates, it yielded a single fluorescent zone when adsorbed from hexane on a column of activated alumina.

These results indicate that at least part of the fluorescing material in the non-saponifiable fractions of liver lipids is probably associated closely with



vitamin A, although it is not clear whether the compound occurs in the liver as such or arises as a transformation product of vitamin A during the saponification and isolation process. The work of Edisbury and co-workers[5] on fish liver oils would suggest the latter may be the case.

Our concentrates were obtained by processes of solvent extraction, saponification, chromatographic adsorption and molecular distillation which will be described in detail elsewhere and which parallel quite closely those employed by Penn and Kaplan. The relationships between ultra-violet absorption spectra and fluorescence spectra are still not well understood; but the presence of fine structure in the near ultra-violet absorption of these fluorescing concentrates suggests the possibility that the banded fluorescent spectrum observed by Penn and Kaplan might have arisen from a similar substance.

The carcinogenic action of these liver extracts was negative when tested by subcutaneous injection in tricaprylin solution in mice. Since these extracts were essentially free from sterol, these observations do not contradict the findings of Hieger[6] concerning the carcinogenic activity of cholesterol fractions from similar source material.

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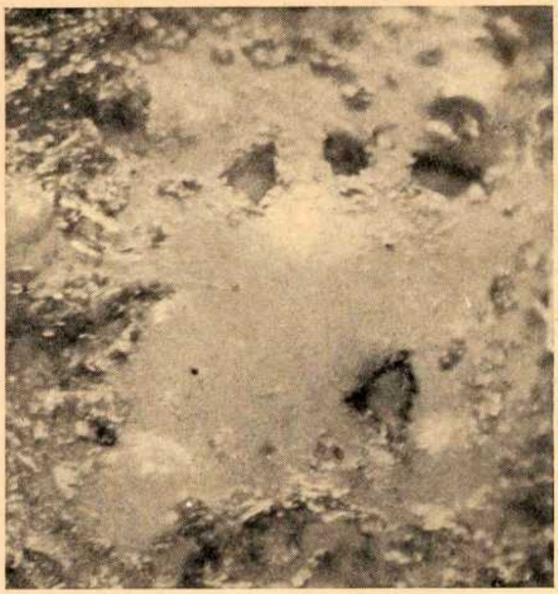
Tensile Stress as a Factor in Fern Phyllotaxis

ANATOMICAL investigations of the development of leaf primordia in the broad shield fern (*Dryopteris aristata* Druce)[1,2] have led me to the view that during growth each primordium sets up tangential tensile stress in the apical meristem above its axil. A further hypothesis is that the next primordium to be formed arises in that region of the apical cone in which tensile stress is minimal. It has been observed that meristematic tissue in regions subjected to tensile stress typically develops into parenchyma.

In his "Allgemeine Morphologie der Gewachse" (1868, p. 508), Hofmeister has advanced a hypothesis on the same general lines. He has suggested: (1) that the outer walls of the superficial cells of the shoot apex offer resistance to the lateral outgrowth of new organs (primordia); (2) that this resistance is not uniform over the growing point, new lateral organs appearing in regions of greatest elasticity; (3) that in proximity to the last formed primordia the superficial membrane, being already stretched, has minimal elasticity; (4) that a new primordium will appear in that position on the apex which lies farthest from the last formed primordia, that is, in the position of maximal elasticity and minimal tension. While Hofmeister's observation that new leaf primordia arise in the largest gap has been accepted by many investigators of phyllotaxis, his mechanical theory outlined above has received little support.

Already Snow and Snow[3,4] have shown that if the vegetative apex of several different flowering plants is incised, either transversely or longitudinally, the cuts typically gape. They have used this information to refute the view of Schuepp[5,6] and Priestley[7] that there is more rapid growth of the superficial than the internal tissue at the apex and hence that leaves arise as a result of compressive stress; but they have not directly suggested that the presence of tensile stress in the apical meristem may be a factor determining phyllotaxis (in conjunction with other factors).


DOWNWARD VIEW OF THE SHOOT APEX OF *Dryopteris aristata*. THE CIRCULAR PUNCTURE (TOP CENTRE) IS IN THE POSITION OF THE NEXT LEAF PRIMORDIUM TO BE FORMED. THE PUNCTURE IN THE AXILS OF THE PRIMORDIA (TOP LEFT AND RIGHT) ARE DISTENDED TANGENTIALLY, AS IS ALSO THAT OF THE PRIMORDIUM (BOTTOM RIGHT) BELOW. (× 40) (PHOTO. BY ERNEST ASHBY)

Preliminary studies of the distribution of growth in *D. aristata*, in specimens in which the apical region had been covered with a thin layer of lamp-black (applied as a suspension in 10 per cent gum arabic), support the hypotheses now advanced. Furthermore, when apices were laid bare and incised or punctured in different regions, positive evidence was obtained of the existence of tensile stress in and above the axil of each primordium, whereas stress was slight or absent in those regions in which the new primordia would arise (see accompanying photograph). The largest unoccupied space on the apical cone above the level of the last formed primordium, which, as Snow and Snow have pointed out, is the position in which the next leaf primordium will arise, is also that region of the apical meristem in which tensile stress is minimal. Why the imposition of tensile stress should affect the further development of the distinctive meristematic tissue at the shoot apex of ferns as it does is still obscure. The problem is an interesting one: its solution may be of considerable importance to our knowledge of morphogenetic processes.

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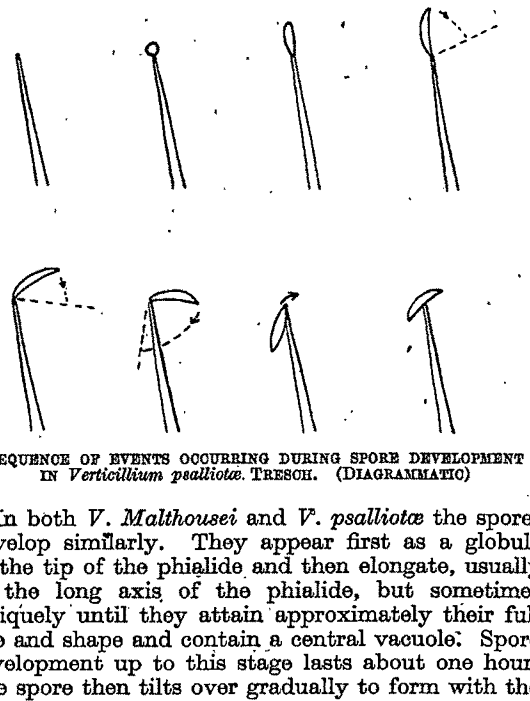
Passive Movements of Newly Formed Acrogenous Spores in *Verticillium* and Some Other Genera of the Hyphomycete Fungi

THE development of the spores in two species of *Verticillium*, namely, *V. Malthousei* Ware and *V. psalliotæ* Treschow, both parasitic on the cultivated mushroom *Psalliota* sp., was reported by Treschow[1] to be different. He observed the spores of *V. psalliotæ* lying transversely across the tips of the phialides on which they were developed. He concluded from this observation that the spores, which originated as a minute globule, grew out on either side perpendicular to the long axis of the phialide. He did not observe this transverse arrangement in *V. Malthousei* Ware, and neither did Ware[2] himself. It was, however, recorded in illustrations of this fungus by Atkins and Bulloch[3]. My own observations from time to time confirmed this record. More recently, I decided to compare the development of the spores in both these species under similar conditions, by continuous observation, using a moist chamber placed on slide cultures.



SEQUENCE OF EVENTS OCCURRING DURING SPORE DEVELOPMENT IN *Verticillium psalliotæ*. TRESCH. (DIAGRAMMATIC)

In both *V. Malthousei* and *V. psalliotæ* the spores develop similarly. They appear first as a globule at the tip of the phialide and then elongate, usually in the long axis of the phialide, but sometimes obliquely until they attain approximately their full size and shape and contain a central vacuole. Spore development up to this stage lasts about one hour. The spore then tilts over gradually to form with the long axis of the phialide an angle of about 120°. Eventually, it continues to tilt, but more rapidly, sometimes even suddenly, to an angle of 90° or less. Then, after a short interval, while remaining in the plane perpendicular to the long axis of the phialide, it suddenly describes an arc through an angle of 90°, but sometimes 180°, and then almost immediately slips across the tip of the phialide to lie in the transverse position recorded by Treschow for *V. psalliotæ* and by Atkins and Bulloch in their illustrations of sporing phialides of *V. Malthousei*. In agreement with these various authors, I observed that in *V. Malthousei* many spores developed in succession at the tip of the same phialide, the first formed becoming levered out of its horizontal position by the second spore, which followed later. These spores remained clustered together in a drop of fluid. In the case of *V. psalliotæ* I have not so far observed the formation of more than one spore at the tip of each phialide, except in an isolated instance where two were formed in succession.

These spore movements which I have described for two species of *Verticillium* explain the misinterpretation by Treschow of the transverse position of the spore relative to the phialide in *V. psalliotæ* and the uninterpreted illustrations of *V. Malthousei* by Atkins and Bulloch.

From preliminary observations of spore development in some other genera of Hyphomycetes bearing non-pedicellate spores, notably *Cylindrocarpon*, *Fusarium* and the *Clonostachys* form of *Gliocladium*, it seems that movements of a similar nature and occurring in the same sequence are not confined to the genus *Verticillium* but probably occur in many other genera. I have, however, observed movements of a different nature often occurring in *Cylindrocarpon* and in *Fusarium* as an alternative to those I have described.

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Regulation of the Sodium–Potassium Ratio in Insects

THE variability of the sodium–potassium ratio in the cœlomic fluid of different species of insects and its association with the normal diet has been pointed out in previous papers[1,2]: the vegetarians having a high potassium concentration, the carnivorous insects a high sodium concentration in their cœlomic fluid.

In order to ascertain the nature of this association, the following hypotheses were tested: (1) The sodium–potassium ratio of the food might have a direct influence on the composition of the cœlomic fluid through lack of regulatory mechanisms in the insects. This possibility was suggested by the similarity between the sodium–potassium ratio of the cœlomic fluid and that of the diet; thus it is greater than 1 in the carnivorous insects and in animal fluids, less than 1 in vegetarian insects and in plant cells and saps. Carnivorous insect (*Calliphora erythrocephala*) and vegetarian insects (*Ephestia Kühniella*, *Pieris rapæ* and *Vanessa urticæ*) were raised from young to full-grown larvæ on diets with modified sodium–potassium ratio, all other factors being equal. This was done either by dialysing meat and wheat flour against solutions of various ionic

TABLE 1. NA/K REGULATION IN THE CŒLOMIC FLUID OF INSECTS

Insects and diets	Ions concentration in equiv./kgm.			
	In the diet		In cœlomic fluid	
	Na	K	Na	K
Calliphora erythrocephala (6 days on dialysed meat)	0·082	0·007	0·158	0·037
	0·010	0·111	0·083	0·040
Ephestia Kühniella (35 days on dialysed flour)	0·098	0·011	0·030	0·047
	0·098	0·011	0·027	0·056
	0·008	0·115	0·016	0·059
	0·008	0·115	—	0·065
Pieris rapæ (5 days on cabbage)	0·006	0·077	0·010	0·075
	0·006	0·077	0·013	0·074
	0·027	0·061	0·009	0·080
	0·027	0·061	0·010	0·077
Vanessa urticæ, 2 days on:				
Leaves	0·010	0·100	0·022	0·043
Leaves coated with NaCl	0·366	0·088	0·058	0·049
Leaves coated with KCl	0·010	0·700	0·021	0·080

ratios, or by cultivating cabbages on coastal and inland soils, and also by coating leaves with salt solutions.

From the results (Table 1), a regulatory mechanism capable of dealing with the ionic composition of both diets is therefore undoubtedly present in insects.

(2) Unsuspected constituents of the diet might have an influence on the regulatory mechanisms; this eventuality was studied by raising the same insect, *Tenebrio molitor*, on a vegetable diet (cabbage and flour) or on a powdered meat diet. After 3½ months, the sodium and potassium concentration in the cœlomic fluid of the two batches was unaffected, as shown in Table 2.

TABLE 2. INFLUENCE OF THE DIET ON THE CŒLOMIC FLUID COMPOSITION OF *Tenebrio molitor*

Diet (during 3½ months)	Ions concentration in equiv./l.	
	Na	K
Cabbage + wheat flour	0·091 0·090	0·040 0·042
Meat	0·097 0·096	0·042 0·042

From these experiments, we may conclude that the association observed between the sodium–potassium ratio in the cœlomic fluid and the diet is not the result of the chemical composition of the foodstuff acting during the actual life of a given insect. The ionic composition of the internal medium, as found now, is a species characteristic, maintained by mechanisms of mineral regulation.

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Chick Embryos Surviving the Inoculation of an Equine Strain of Encephalomyelitis Virus

DURING routine work for the preparation on a big scale of embryo chick vaccine against equine encephalomyelitis, we observed that of 400 chick embryos 10–11 days old, inoculated with 0·05 ml. of a 20 per cent suspension of the infective brain tissue of guinea pig, there were sixty surviving embryos which continued development without inconvenience, judging by the trans-illumination control. Afterwards, and with the object of avoiding this effect, precautions were adopted to obtain the maximum mortality figures. Again, 400 chick embryos, 10–11 days old, were used and inoculated with the same virus strain with a dose of 0·1 ml. of a 30 per cent suspension of infective brain tissue of guinea pig taken from animals in the agonic period of the experimental encephalomyelitic infection. The effect was repeated; and about 10 per cent of the inoculated embryos behaved apparently like refractory animals, producing in due course well-shaped chicks.

In six other experiments, where 2,000 chick embryos, 9–12 days old, were used, it was found that if the experimental conditions were not changed, there were always chick embryos which, although having been duly inoculated, did not appear to be affected in their vitality after having received extraordinary amounts of active virus.

Further, experiments were also made, not only to check the observations, but also to study the possible influence of the age of the chick embryo, as well as the concentration of the virus at the dose used.

In all experiments we used a strain of virus of the encephalomyelitis equine West type maintained by passages in guinea pigs of 350–400 gm. weight, every 30 days, exclusively by the intralingual route.

Starting from brains extracted from guinea pigs in the agonic period, that is to say, 4½–5 days after inoculation, we made suspensions in buffer solutions at 7·2 pH with previous trituration and centrifugation of the infectious tissues. We chose, during the last assay, the dilution 10^{-1} at a dose of 0·1 ml. by the intra-alantoides route. This dose represents, on the basis of calculations made according to the recommendation of Reed and Muench[1], 500 L.D. (50) for guinea pigs by the intralingual route and 50 L.D. (50) for mice 28–30 days old by the intra-abdominal route; this last calculation is subject to the considerations quoted by Sabin and Olitsky[2] and Olitsky and Harford[3]. The age of the embryos we used was carefully controlled, and adequate controls were used for the inoculation technique, as well as for the maintenance of the chosen dose in contact with the embryonic tissues. Every inoculated embryo which died was extracted, and with previous trituration and dilution, inoculations into virgin guinea pigs and mice produced the encephalomyelitic infection.

Of 166 inoculated embryos, 22 which survived were tested and many of them born, presenting in all cases good vitality 96 hours after having received the corresponding doses.

Summing up our accumulated experience on the special behaviour of this virus strain of the encephalomyelitis equine West type, it is proved that it was not possible to obtain a regular mortality in chick embryos inoculated with a considerable dose of virus, and, further, that chick embryos younger than 9 days perish regularly due to the mortal action of the virus strain employed. Embryos older than 8 days, which have resisted alive the inoculation of a concentrated dilution of the strain studied, are comparatively less susceptible than guinea pigs and mice.

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Nephrotoxic and Renotropic Effects of Lead on White Rats and its Prevention by *B.A.L.*

THERE have been many studies on renal injuries produced by lead, but so far as we are aware, mention has never been made of a renotropic effect of lead.

Daily administration to white rats of 2 c.c. of a 4·5 per cent lead acetate solution by stomach tube produced an increase of weight in the kidneys, which was already appreciable at the ninth day and persisted in rats poisoned throughout periods of three, five and twelve months (see table). No changes in blood pressure were observed throughout the experiments. Controls received 2 c.c. of a 4·5 per cent sodium acetate solution. Microscopic study of the kidneys of lead-treated animals showed degenerative lesions in the cells of Henle's loop and simultaneously signs of intense regeneration with large anomalous nuclei.

EFFECTS OF LEAD ACETATE ON THE WEIGHT OF THE KIDNEYS OF FEMALE WHITE RATS, CALCULATED PER 100 CM.² OF BODY SURFACE

Treatment	Duration of experiment (days)	Number of animals	Body-weight, average (gm.)	Kidneys weight, average (gm./100 cm.²)
Lead treated	9	10	114± 4·7*	0·552±0·019*
Controls	9	10	128± 5·4	0·395±0·012
Lead treated	150	8	181± 6·5	0·499±0·016
Controls	150	5	196±12·0	0·367±0·012
Lead treated	365	7	190±11·2	0·653±0·037
Uninephrectomy. Proteins and NaCl lead	90	6	175± 8·8	0·512±0·023
Uninephrectomy. Proteins and NaCl.	90	4	191± 9·9	0·398±0·023

* Standard error.

Hypophysectomy or adrenalectomy did not prevent the increase of weight and renal injury when lead salt solution was given to rats for a period of ten days.

Uninephrectomized rats fed on a standard diet and given lead for a period of six months had a tubular mass, as determined by diodrast excretion, 25 per cent greater than that of normal animals with both kidneys. Uninephrectomized controls on the same diet, but without lead, had a tubular mass 20 per cent below that of normal rats[1]. Uninephrectomized rats fed a diet rich in protein and sodium chloride and treated with lead throughout a period of three months had the same degree of hypertrophy of the tubular mass as those treated with lead and fed a standard diet.

The increase of kidney weight produced by giving the 4·5 per cent lead solution during ten days was almost completely prevented by injecting intraperitoneally twice daily 33 mgm. per kgm. of body-weight of a 2–3 dimercaptopropanol (*B.A.L.*) solution in distilled water. Microscopic study confirmed the results of the macroscopic observations.

It is worth mentioning that *B.A.L.* did not prevent the anæmia of lead poisoning in this species.

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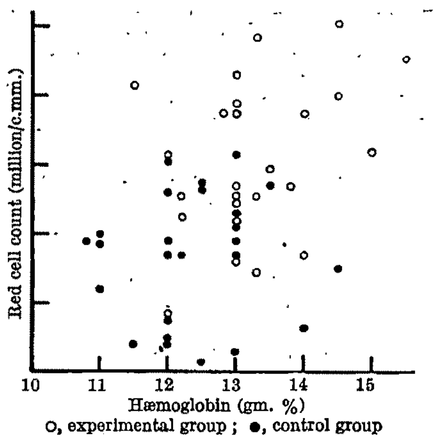
Induced Polycythæmia by *l*-Ascorbic Acid in Albino Mice

THE effect of *l*-ascorbic acid in increasing the number of red blood corpuscles has been studied in various laboratory animals[1] but hitherto not in mice. The present investigation was made to ascertain the action of the vitamin on the latter animal, taking into consideration, at the same time, the fact that there are many dietetic factors which affect the blood picture. Thus besides being properly fed on a diet consisting of cabbage and a mixture of cereal flour (8 parts) and whole milk powder (2 parts), the animals were given a salt mixture of iron, copper and cobalt (42, 55, 0·03 p.p.m. respectively[2]) and cod liver oil.



The animals, all male, were procured from the market and kept in the laboratory for one month before the experiment. Half received ascorbic acid and half served as control. Each mouse in the experimental group was fed daily 0·5 c.c. of a 4 per cent vitamin solution with a tuberculin syringe. The solution was prepared afresh every day. At the end of the third week, blood samples were taken from the tails of the animals. The red cell count was made with a Neubauer counting chamber after dilution with Hayem's solution. For hæmoglobin determination, the colorimetric acid-hæmatin method was employed.

EFFECT OF ASCORBIC ACID ON MEAN RED CELL COUNT AND HÆMOGLOBIN VALUE OF MALE ALBINO MICE

Duration of experiment, 3 weeks. Number of mice in each group, 25. Ascorbic acid fed to experimental group, 2 mgm./mouse/day

	Average initial body wt. (gm.)	Average final body wt. (gm.)	Mean red cell count (million/c.mm.)	Mean hæmoglobin (gm. per cent)
Control group	15·1±0·30	20·4±0·36	9·70±0·124	12·36±0·125
Experimental group	15·2±0·35	19·2±0·39	11·12±0·143	13·25±0·132
Difference			1·42 5·07	0·89 3·59

The results, as summarized in the accompanying table, show that there is a general increase in the average body weight and that the mean red cell count and hæmoglobin value of the 25 mice in the experimental group are higher than those of animals in the control group. When the values of the red cell count and hæmoglobin are presented simultaneously in a graph, the points for the two groups can be seen to have different centres of distribution. The significance of the data, however, was clearly shown by treating them statistically. By the *t*-value method[3], the probability that the difference is due to chance is found to be 0·001 in the case of hæmoglobin value and less than 0·001 in that of the red count.

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DETECTION OF THE FREE AMINO-ACIDS OF PLANT CELLS BY PARTITION CHROMATOGRAPHY

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ACCORDING to the classical and perhaps most generally accepted theory of protein synthesis in plants the amino-acids are intermediates in a process which proceeds after the pattern first outlined by Emil Fischer in the well-known polypeptide theory. On other views the amino-acids are regarded rather as the products of protein hydrolysis and as the form in which soluble nitrogen may be stored and eventually mobilized when synthesis proceeds[1]. Whichever of these views is held, it is a commonplace that free amino-acids are widespread in plants and they are known to exist dissolved in the cell sap, to which they contribute part of the buffering properties which titration curves reveal. This is neither the place nor the occasion to give the number of free amino-acids which have been identified in plant materials.

The application of the technique of partition chromatography on paper, devised originally by Consden, Gordon and Martin[2], to the investigation of the soluble nitrogen components of plants is a natural development particularly in view of the further reports of its successful applications in animal biology[3-6]. It is also of interest that a similar technique has been applied to other compounds such as sugars[7].

A note[8] in *Nature* by LaCour and Drew reports, apparently for the first time, the use of this technique on plant material and therefore calls for some special comment.

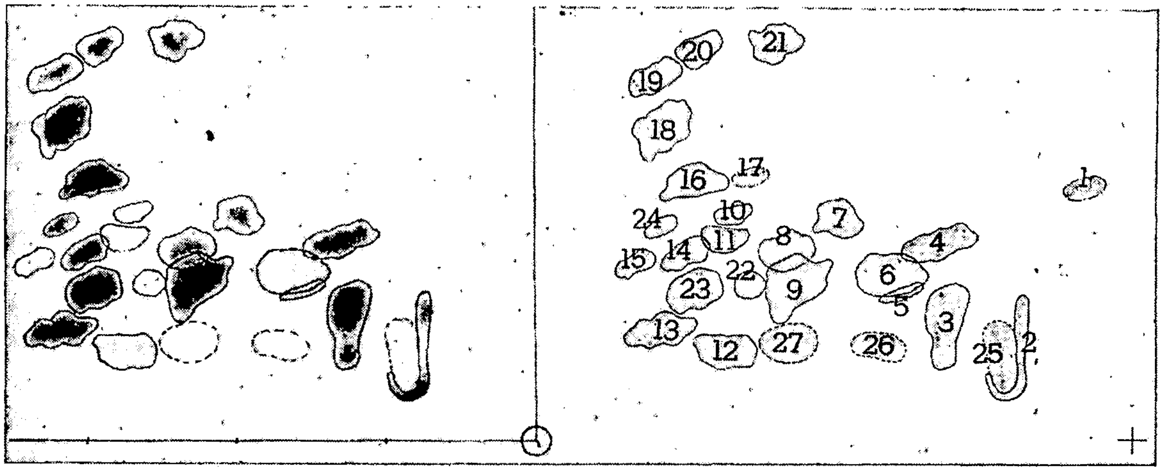
LaCour and Drew examined two types of plant materials: root-tips of *Trillium* and anthers of *Tradescantia* at various stages of development. The tissue was applied to filter paper strips in the form of a smear and the amino-acids were made to pass along the paper strip in phenol saturated with water, in accordance with the 'strip' or 'one-dimensional' technique familiar to users of the paper chromatographic method. On development of the chromatogram with the ninhydrin reagent LaCour and Drew obtained "two or more coloured bands indicating the presence of two or more free amino-acids".

It would indeed be somewhat surprising if plant cells contained as few amino-acids as suggested by the phrase "two or more". Although LaCour and Drew imply some casual relation between "nuclear activity" and the presence of amino-acids, their paper only allows one to conclude that two or more unidentified amino-acids are present in the crushed cells of *Trillium* root tips and the crushed anthers of *Tradescantia*. We therefore find it desirable to report the results of our own use of the paper chromatographic technique in the analysis of plant material. We do this, in advance of the publication of fuller details elsewhere, to show now the possibilities inherent in the method and also the biochemical range which studies of this kind involve.

The tissue at a cut potato surface is known to be capable of rapid metabolism in which protein synthesis from stored reserves of soluble nitrogen is a salient feature[1,9]. In moist air this tissue undergoes a recrudescence of growth which culminates in cell division and the formation of a meristem. In the form of thin disks (0·6 mm. or thinner) the tissues will accumulate salts from dilute solution and, without any inactive core of cells, will show evidence of great metabolic activity. We regarded, therefore, the potato tuber as particularly favourable material to study; first because the tissue is known to be rich in soluble nitrogen compounds, approximately two-thirds of the total nitrogen being soluble in alcohol; secondly, because of its known ability, under specified conditions, to synthesize protein at the expense of these reserves; thirdly, because of the known ability of the cells to grow and divide[10].

Briefly, we have established the following facts. The basic technique of paper chromatography is applicable to extracts of the soluble nitrogen of potato tissue under conditions which we shall specify exactly in a later communication. The amino-acids are best extracted in cold 70–80 per cent alcohol, giving a protein-free solution. The alcohol extracts are evaporated to dryness under reduced pressure without the use of heat and then are redissolved in water to give a solution which contains 10 mgm. of nitrogen per ml. For the chromatography an aliquot of extract containing approximately 50 μgm. of nitrogen (that is, 5 μl. of the solution) is normally used. The amino-acids on the paper square move for approximately thirty hours in phenol saturated with water, then the paper is dried. Afterwards the amino-acids move for approximately another thirty hours in a collidine (2–4–6 trimethyl pyridine)-lutidine (2–4 dimethyl pyridine) mixture (1 : 1 by volume) freshly equilibrated at the working temperature with the same volume of water. We then obtain a chromatogram (see accompanying illustration) which shows within a square of paper approximately 35 cm. by 45 cm. about twenty-four well-defined spots giving typical ninhydrin reactions. In addition there are at least three as yet unidentified constituents which appear yellow on the paper. By this means, positive and, we believe, unequivocable identification has been achieved of twenty-one amino-acids as normal constituents of the alcohol-soluble nitrogen of potato tuber tissue and three more still await final identification. So far as we are aware, this is the first systematic application of this relatively new technique to plant material, and some of the amino-acids thus identified will be reported for the first time to be present free in potato tissue and in plants.

A list of amino-acids (in the approximate order in which they are spread on the paper) which we have positively identified in the cold alcohol extract is as follows: cystine, aspartic and glutamic acids, serine, glycine, asparagine, threonine, alanine, glutamine, α-amino-*n*-butyric acid, histidine, arginine, lysine, methionine sulphoxide, proline, valine, methionine, isoleucine, phenylalanine, tryptophane and tryosine. Amino-acids which are still subject to investigation and confirmation or which are present in minimal amounts are: β-alanine or citrulline, and two distinct amino-acids near the position occupied by proline on the paper. The two latter substances have been seen by one of us (C. E. D.) in animal material and, therefore, they seem to be of general distribution in Nature. The possible presence of ornithine is still under investigation as there is some



A *B*

A. Two-dimensional paper chromatogram of alcoholic extract of potato tissue applied within the circle shown: direction of movement in phenol shown horizontally, movement in collidine-lutidine vertically. For the purpose of this photograph 150 μgm. of nitrogen were used: this larger amount reveals the relatively weak spots, although it tends to cause overlapping of some of the stronger ones. Using still larger amounts has revealed two constituents not shown here. Before photographing the original chromatogram each distinct spot was ringed with pencil. The photograph does not give a true rendering of the relative intensities of the spots, since it was necessary to 'print-in' certain areas to increase their density. *B* is a key to *A* prepared from a tracing from the original, but also showing the location of methionine and cystine as they are revealed after the extract is treated with H_2O_2. The identified substances are: 1, cysteic acid from cystine; 2, aspartic acid; 3, glutamic acid; 4, serine; 5, glycine; 6, asparagine, which gives a brown ninhydrin reaction; 7, threonine; 8, alanine; 9, glutamine; 10, α-amino-*n*-butyric acid; 11, histidine; 12, lysine; 13, arginine; 14, methionine sulphoxide; 15, proline which, owing to yellow ninhydrin reaction, does not show well in the photograph; 16, valine; 17, methionine sulphone from methionine which when unoxidized is normally obscured by the leucines at position 18; 18, isoleucine (leucine also occupies this position, but an independent method shows the predominance in these extracts of isoleucine); 19, phenylalanine; 20, tryptophane; 21, tyrosine., The as yet unidentified substances are: 22, probably β-alanine, although the position is also occupied by citrulline; 23, an unidentified amino-acid occurring in quantity; 24, an unidentified amino-acid occurring in small amounts; 25, 26, and 27 are unidentified substances of entirely unknown nature which appear as yellow areas on the chromatogram. These interesting substances are generally distributed in Nature, for example, large quantities have been found in normal blood and urine. The substance at position 25 characteristically distorts the spot due to aspartic acid at position 2.

difficulty in detecting it in presence of lysine. We do not claim to have exhausted the possibilities inherent in the method, but we do suggest that these are scarcely evident from the earlier statement by LaCour and Drew.

The mere list of amino-acids, coupled with our semi-quantitative observations, presents at the outset some interesting features. The preponderance of isoleucine over leucine (which we have not yet found) is surprising. Cystine and methionine require special procedure to demonstrate their presence[4] and although they have both been clearly seen they are by no means as conspicuous in the chromatograms as might have been expected. Hydroxyproline has not yet been positively detected. Glutathione can be revealed by the method but has not been seen in the chromatograms. α-Amino-*n*-butyric acid is present only in traces, and in accordance with the previous claim for its presence in blood and urine[6] it is suggested that it is more likely to be a breakdown product of an amino-acid (such as methionine) than an intermediary of protein synthesis.

Under conditions in which protein synthesis is known to occur in potato disks we have been able to show that many of these amino-acids decrease in amount to such an extent as to be no longer detectable in the chromatograms. Others, however, persist throughout in relatively large amounts, for example, glutamine and asparagine, glutamic and aspartic acids, and this is particularly suggestive in relation to the view[1] that in protein synthesis the soluble nitrogen may be drawn from a variety of stored amino-acids but is canalized through the system glutamine $\rightleftharpoons$ glutamic acid en route to protein.

We believe that the technique, in the form in which we have used it, opens a new chapter in the study of nitrogen metabolism in plants. However, the method will only be profitable if it is used in ways which utilize its remarkable selectivity. If the identity of a particular amino-acid cannot be established critically by matching against standards consisting of known amino-acids and by such specific tests as may be carried out either on the paper or on the amino-acid extracted from the chromatogram, the method of Polson, Mosley and Wyckoff[11], using electron defraction, offers other means of approach. It should also be noted that these authors claim to have used the paper chromatogram technique in a more quantitative manner after extracting the product of the ninhydrin reaction in acetone for subsequent measurement in a colorimeter.

Our own experiments will be reported in detail elsewhere, but it is already evident that the method enables one to detect the presence of a large number of amino-acids in plant cells and to reveal both qualitatively and quantitatively the changes which occur when cells, like those of the potato, embark upon protein synthesis and upon the kind of metabolism which normally culminates in cell division. It is true that the alcohol extracts do not localize the amino-acids in any particular cellular inclusion, and it will be necessary to find other means to demonstrate their distribution within the cell.

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ARMY EDUCATION COURSES: PREPARATION FOR MARRIAGE

IN response to the great interest in family problems shown by students at the Command School, the General Officer Commanding, London District, sought leave to hold courses in "Preparation for Marriage" for Army personnel. Permission to hold such courses was granted by the War Office on condition that they should be looked upon as experimental and that attendance should be purely voluntary. Three such courses were held at the Command School, London District, during the summer this year, each of three days duration. The lecturing staff was provided by the National Marriage Guidance Council. In all cases the students were of mixed sex: at one of the courses men and women of all ranks attended together; for the others, officers and other ranks were divided into separate groups. The syllabus was planned to cover the sociology of marriage and the family, biology of sex and reproduction, sexual psychology and ethics, marriage and its adjustments, the emotional development of the child and the adolescent, parentcraft and homecraft. The speakers were Dr. D. Mace, Dr. Edward Griffiths, Dr. Gilbert Russell, Dr. Ethel Dukes, Mrs. Marjorie Hume and Mrs. Vera Mace. A special feature of each of the courses was a 'brains trust' consisting of all the speakers, who dealt at considerable length with each question. The questions themselves reflected a high level of frank and sincere inquiry.

In his report on these courses the General Officer Commanding, London District, is of the opinion that they were a distinct success. There was much evidence, he states, that they were appreciated by the students, who took the subject-matter as being long overdue, welcome and ordinary. As a result of this experiment, he recommends that further courses should be held in the London District, and that the holding of similar ones in other parts of the country should be considered. He also expresses himself as being in favour of permitting certain non-Service people to attend such courses, so that engaged and newly married couples might jointly take part in them. Special courses, he considers, should be held for married families in the Regular Army; and for the Roman Catholics separate arrangements should be made. It was generally agreed that the time allotted to these courses should be extended from three to four days.

It is stated that the Archbishop of Canterbury and the former Secretary of State for War regard these experimental courses as important preliminaries to Army-wide consideration of this vital subject. There would seem to be every justification for holding further ones and for widening their scope. These first courses were attended by carefully selected students who were engaged to be married, married, or sincerely interested; their ages tended to be higher than that of average Service personnel. Even so, there must be large numbers of similar men and women in the Services who would be glad to avail themselves of such valuable information and advice. Yet to restrict these courses on preparation for marriage to such students alone would be severely to limit the usefulness of what promises to become a most valuable branch of the educational service. For it is well known that in all the Services interest in sex and in personal relationships associated with sex runs at a very high level, while the temptations of physical gratification in surroundings away from home-circles are strongly intensified. The high incidence of venereal disease among members of the Forces is further evidence, not only of a medical and moral problem of serious dimensions, but also of the urgent need for a widely extended educational and advisory service which would have as its object the fostering of happy and harmonious family life.

To provide speakers with suitable training and outlook for such a service would at first throw a serious strain upon the National Marriage Guidance Council as well as upon the other voluntary organisations who are interested in sexual problems and family life. After a time, however, it should be possible for the Services to develop their own special educational and advisory staff. The preliminary courses also revealed a great need for a good supply of the right kind of books.

R. WEATHERALL

PHYSICS AND THE STEEL INDUSTRY

NEW LABORATORIES OF THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

THE laboratories of the Physics Department of the British Iron and Steel Research Association were officially opened by Lord Rayleigh on October 22. They are at 140 Battersea Park Road, London, under the charge of Mr. M. W. Thring, with a scientific staff numbering between forty and fifty. This is the second laboratory to be opened by the Association since its formation in 1945, the South Wales establishment having been opened on July 3 (see *Nature*, July 19, p. 100). The purpose of these laboratories is to enable the Association to carry out its function of supplementing and 'backing up' the great volume of research carried on by individual firms within the iron and steel industry. Before the formation of the Association, Corrosion Laboratories at Birmingham and the Marine Biology Laboratories at Millport (Scotland) were already in existence; experimental open hearth and blast furnaces have been constructed by the Association at Stoke-on-Trent, and plans are well advanced for the establishment of a metal-flow research station at Sheffield, which will complete the Association's immediate plans for the establishment of its own research stations.

Mr. G. H. Latham, president of the Association, presided at the informal lunch which marked the opening of the Physics Laboratories, when Lord Rayleigh spoke of the opportunities for physicists in the metallurgical field. Lord Rayleigh recalled discussions with Prof. Max Planck, Prof. H. L. Callendar, Sir Charles Parsons and others on the subject, and commented on the possibilities before the physicist in connexion with pyrometry, continuous casting, heat-resistant alloys and other such subjects. He commented on the increased organisation behind modern research, and "the great contributions to science and technology" that such organisation could make possible. Research had become a career, as a gathering such as that one demonstrated, and it was with pride and pleasure that he declared the Physics Laboratories open.

Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, spoke briefly and wittily in wishing that the work of the staff might be "exciting as well as fruitful and productive. . . . Your industry abounds with opportunity for the physicist", he said. "It was Isaac Newton himself who first posed the theoretical problem of elucidating the strength of materials—of explaining why the contiguous parts of a solid stick together, and that problem still gives people something to think about even to-day." He paid a warm tribute to Sir William Larke's zealous and selfless work for industrial research. "Although the Research Association is in itself youthful", he said, "the research spirit has for many years been alive in the iron and steel industry, and it must be gratifying to the pioneers to see the steady development of the central research organisation under the vigorous leadership of your council and your director, Sir Charles Goodeve."

Mr. D. A. Oliver, head of the research department of the B.S.A. group of companies, spoke on behalf of the Council of the Association. Emphasizing the close relations between fundamental physics and the steel industry, he instanced Dr. Schofield's work on the quick-immersion thermocouple, and work at the Association's laboratories on lead sulphide cells, aerodynamic flow through models, spectroscopy and X-ray crystallography. He laid great stress on the close relations between the Association, industry, the universities and other research organisations.

After lunch the guests proceeded to an inspection of the new laboratories. These are disposed on two floors of a factory building, and comprise some 14,000 sq. ft. of laboratory and office space. Their equipment includes a 50-kW. output high-frequency induction furnace, X-ray diffraction apparatus, a 3-in. aperture black-body furnace (designed and built at the laboratories) for use up to 1,700° C. for calibration of pyrometers, and a complement of laboratory and steelworks equipment.

The arrangement of the Physics Department is based on a plan approved by the governing council of the Association in 1946, which envisaged three main functions for the Department. These are: (1) to keep in touch with the advances of physical science with a view to possible application in the iron and steel industry; (2) to carry out research into the more fundamental physical problems connected with the work of the Association; (3) to carry out on behalf of the various divisions of the Association, research and development in fields of physics which are common to more than one division.

The Department may therefore be described as a 'horizontal' department in the Association's organisation, carrying out fundamental research to assist any or all of the six divisions under which the bulk of the work is organised. These six 'vertical' divisions correspond to the main divisions within the iron and steel industry, and are largely autonomous in operation. It is therefore an additional function of the 'horizontal' departments to assist in maintaining liaison between the divisions.

In implementing this programme two guiding principles have been adopted. (i) Experimental work should be backed up by theory wherever possible in order to avoid laborious testing of every combination of conditions ('long-shelf' research). (ii) The use of similarity theory can greatly enhance the value of a research laboratory by enabling it to test on a fundamental scale the key laws underlying complex industrial processes. This is particularly true in the iron and steel industry, where processes are too involved to permit the reduction of conditions to a form which can be solved by physical measurements of the required coefficients and mathematical solution of the corresponding differential equations.

These considerations have led to the division of the work of the Department into five broad categories, each organised under a section with a separate laboratory and office accommodation in the Department's laboratories. The sections are general physics, instruments, heat and thermodynamics, aerodynamics and mathematics. Guests inspecting the laboratories were able to see work in progress in each section, organised on the following lines.

General Physics Section. This is concerned with the state of the physical properties of steel and the metals used in steelmaking, and the interrelations between these properties. In order to avoid overlapping existing programmes, this field has been narrowed by the choice of bulk rather than surface properties, and by an emphasis in the direction of the properties of iron and steel above 1,200° C., that is, in a temperature range concerned rather with manufacture than with use. Work on continuous casting, in so far as it is concerned with experiments of heat transfer and plastic flow and with models of commercial processes, is being carried out by the General Physics Section, which in addition to its main laboratory has an X-ray laboratory and dark rooms.

Instruments Section. This is concerned with the large and increasing use of instruments in the steel industry. Recent developments in instrument design have raised new possibilities, and a part of the work of the Instrument Section is to bring together the instrument industry and the iron and steel industry in improving the supply and application of existing instruments. Its other main line of work is to develop new instruments, and work is proceeding in connexion with the measurement of the tension of wire in the process of drawing, a remote-reading electrical pressure meter for furnace pressures, and new developments in automatic temperature and radiation recording.

Heat and Thermodynamics Section. Problems of radiation, temperature measurement and heat transfer, which are of vital importance to the steel industry, are dealt with in this Section, which has a high-temperature laboratory in addition to its main laboratory. The Section is working on projects concerned with the development of methods for measuring the thermal properties of flames in furnaces, the exact assessment of the properties of radiation pyrometers and the development of a black-body furnace for their calibration, and the development of improved methods for surface temperature measurement.

Aerodynamics Section. This Section is concerned with all problems of flow, whether of gas in furnace systems or of liquids such as molten steel, slag and iron, and granulated solids. Such work is largely carried out by means of models, such as those used to investigate the flow of gases in an open-hearth furnace or the action of air-jets on the steel in a side-blown converter. The first problem in such cases is to determine which physical properties govern the process, and hence what is the correct similarity criterion which governs the time-scale of the model after the dimensional scale has been fixed by considerations of convenience.

Mathematics Section. A Section to deal with mathematical investigations has been introduced to ensure that problems which are examined experimentally will be dealt with also in terms of theory. It has already been found that more projects are coming along for calculation than can be dealt with by the number of staff originally planned. Among such problems are the heat transfer in continuous casting, the effect of oxygen on the thermodynamics of the blast furnace, the statics of furnace roofs when made with basic bricks, heat transfer in immersion pyrometers and in furnace systems, and the thermodynamics of the Bessemer converter.

There is also provision at the Physics Department's laboratories for a laboratory for the Association's Chemistry Department, and one for the Steelmaking Division. The former is devoted to investigations into the fundamental thermodynamic and kinetic aspects of the behaviour of iron and other elements during the process of iron and steel making. Dr. F. D. Richardson is in charge of this Department. The Steelmaking Division (under Dr. A. H. Leckie) carries out at Battersea work connected with instruments and process chemistry. In this connexion guests at the opening were able to inspect a mobile laboratory for use in steel works, which, mounted on an ex-army lorry chassis, has been designed by the Steel-making Division and assembled at the Physics Laboratories.

MARKET RESEARCH

THE importance to the manufacturer of acquiring accurate knowledge of his market is now becoming generally recognized. Should there have been any residual doubts, they were rapidly dispelled at the conference on market research conducted by the Manchester Joint Research Council on October 22, when the following papers were presented: "The Technique and Applications of Market Research", by Mr. O. W. Roskill (senior partner, O. W. Roskill, Industrial Consultants), "The Investigation of Trends of Consumer Tastes", by Mr. L. R. England (chief research officer, "Mass Observation"), and "Market Research and the Seller", by Mr. D. S. F. Vernon (Calico Printers' Association, Ltd.).

Mr. Vernon directed attention to influences such as machine production and increased mobility which were at work in the nineteenth century and which had the result of separating the producer from the consumer: "It is to bridge the gap between producer and consumer and appreciate more clearly 'consumer preference' (consumer requirements) that a scientific study of these factors has come to the fore under the label of Market Research". The other speakers noted the remarkable lack of knowledge of their own markets which was displayed by many manufacturers, even the efficient ones; and interesting examples were given by Mr. England and the other speakers of astonishing misconceptions as to the strength (or weakness) of customers' preference for a particular product.

In describing the technique of market surveys, Mr. Roskill observed four main avenues of investigation calculated to facilitate the establishment of the manufacturer's sales plan: the division of consumption into the separate uses for the goods in question, a survey of the factors affecting demand, an analysis of the channels of distribution and a knowledge of competition.

As might well be expected from a conference taking place in Lancashire, the treatment of the subject of market research was by no means confined to its relationship with consumable goods. In particular Mr. Vernon was concerned with the importance of investigations of textile markets, where the product is not one which is packed at the factory ready for final consumption, but a fabric which may be used for a variety of purposes. Similarly, Mr. Roskill devoted considerable attention to the technique of market research in relation to producer goods, and it is refreshing to note his emphasis upon the marketing problems which confront those manufacturers who are not concerned with the final retail consumer, but as sellers of semi-finished material, machine tools and other forms of industrial equipment are involved as links in a long chain of manufacture. In consequence, any analysis of the factors affecting the demand for their products cannot be limited to one immediate customer, but may involve an investigation extending into industries one, two, or even three times removed from the industry immediately under survey.

An aspect of market research which might perhaps have been elaborated with profit is the extent to which the manufacturer, having been presented with an analysis of his market, could venture to mould the demand to correspond with his manufacturing conditions. In so far as the market survey discloses the reasons for the preferences of customers, it should be possible to make some estimate of the risks involved in persuading them to accept articles which do not entirely conform to their tastes and prejudices, but which present advantages from the manufacturing point of view. The problem is one which is exercising the minds of manufacturers to-day, particularly those concerned with export markets, and invaluable guidance would be given to them if it were possible to assess the probable reactions of foreign customers, for example, to a policy of greater standardization directed towards the reduction of manufacturing costs by increasing the length of runs on relatively few models.

PROBLEMS OF SOIL AND LAND CLASSIFICATION

THE newly formed British Society of Soil Science held its first conference during September 26–29 in Oxford; the principal topic of discussion centred on problems of soil and land classification.

The first session was devoted to the problems of soil classification, which fall into two categories: how far can soils, which show continuous gradations from one type to another, be divided into types with sufficiently sharply defined differences, so that a soil map can be made of a whole region; and whether the soil map should be made without any reference to the use to which it will be put. Mr. C. G. T. Morison (Oxford), Prof. G. W. Robinson (Bangor) and Prof. S. W. Wooldridge (London) read papers at this session and many members took part in the discussion.

The first two speakers were concerned with mapping soils by 'associations'. In any one region the soil will vary because, as Prof. Robinson put it, the soil is a passive agent of variable constitution acted upon by climate, vegetation and so forth, and these vary over the region. In many regions most of these active agents remain fairly constant with only one or two changing appreciably. Such an area can then be mapped, not by mapping the individual patches of the different kinds of soils present, patch by patch, but by indicating that all variations occur in regular succession between certain types. This includes both the ordinary method of mapping associations and Milne's method of recognizing catenas. The principle is easily applied if only one soil-forming factor is varying appreciably over the region, but becomes more difficult to apply if several are varying. Prof. Wooldridge discussed the more specific problem of the value of recognizing the geomorphological age of the surface on which the soil is formed, and illustrated the points he made by discussing the chalk surfaces of southern England.

The second session was devoted to problems of land classification. Here the problems are of immediate interest to the community, since they concern the conflicting demands upon the use of land for buildings, mineral exploitation and food production. Dr. E. C. Willatts described some of the problems confronting the administrator who has to approve certain types of land use, developments and changes to ensure they are consistent with the policy laid down in the White Paper on "The Control of Land Use" (Cmd. 6537) and in subsequent legislation. By clearly stating the problems facing land planners, he hoped that soil surveyors and other people who had to assess the value of land would prepare their results in such a form that the administrator could easily understand and use them.

Dr. D. A. Osmond gave the definitions, adopted by the West Midland Group on Post-War Reconstruction and Planning, for classifying agricultural land into three categories of good, medium and poor on the basis of its inherent features of site and soil. Site involves the consideration of aspect, slope and elevation, while water-conditions, depth and texture are taken into account as soil factors. Using this simple classification, the major categories of agricultural land can be readily picked out. Eight western counties of England have been mapped on this basis. Because of the high farming on soils frequently of medium quality, market garden areas such as the Vale of Evesham, and some other districts, are included in sub-categories of good agricultural land.

Mr. F. R. Day (Oxford) then discussed criteria for judging the economic value of land for forestry. He showed that if the tree is to come to a proper height at maturity, or at a given age, there is an optimum curve relating its rate of growth with age for each species of tree in a region. Any falling off from this curve is due to some soil factor making the site less suited for the economic exploitation of that species. He illustrated these points by discussing the rate of growth of forest on thin or wet land, often considered suitable for forestry because unsuitable for agriculture, and showed that growth of many species is too slow for economic exploitation, even though initially the growth may be very rapid.

Finally, Mr. G. R. Clarke (Oxford) described the gravel survey of the London area, a survey undertaken to map the good, medium and indifferent agricultural soils overlying the gravel. The object was to see how far it would be possible to prevent the exploitation of the gravels under the best agricultural and market garden land and to continue their exploitation under the poorer soils. Unfortunately, as Prof. Wooldridge later pointed out, there are many different types of gravels, and some essential for making concrete only occur in sufficient quantity under some of the best agricultural land.

TUBERCULOSIS OF VOLES AND SHREWS

It is ten years since Dr. A. Q. Wells reported the presence in the wild vole (*Microtus agrestis*) of a murine type of tubercle bacillus; since then a good deal of work has been done upon this organism. Tuberculosis has been found also in the bank vole (*Clethrionomys glareolus*), the wood mouse (*Apodemus sylvaticus*) and the shrew (*Sorex araneus*), and the relationships of this murine type of tubercle bacillus to the bacilli which cause human and avian tuberculosis have been carefully studied. The present position of our knowledge of the problems raised by the discovery of this bacillus has now been ably stated by Dr. A. Q. Wells in a report entitled "The Murine Type of Tubercle Bacillus (The Vole Acid-Fast Bacillus)", to which Dr. A. H. T. Robb-Smith has contributed notes on the morphology of infection by the vole acid-fast bacillus.*

Illustrated by very clear photographs and by graphs and diagrams, this report is a valuable addition to the literature about tuberculosis. The structure, cultivation, antigenic structure, pathogenicity and other features of the vole bacillus are all discussed, and Wells concludes that the statement that the disease which it produces is tuberculosis "seems justified, in spite of the fact that tuberculosis as a disease of other wild animals in their natural habitat has not hitherto been found". It is not possible to separate the vole bacillus from the human or bovine bacilli tubercle by serological methods; animals infected with the vole bacillus are sensitive to human or bovine tuberculin, and animals infected with human or bovine tubercle bacilli are sensitive to a tuberculin prepared from the vole bacillus. The vole bacillus can, moreover, produce progressive disease of the animals which it can infect, and this disease is indistinguishable from that produced by human or bovine tubercle bacilli. The vole bacillus is therefore a third type of tubercle bacillus. One of the most valuable sections of this report discusses experiments which have been designed to find out whether experimental infection of laboratory animals with the vole bacillus will confer any degree of immunity to the human or bovine tubercle bacilli. The use of a vaccine prepared from the vole bacillus for the production of immunity in man is also described; and the instrument used for some of these experiments, which enables forty simultaneous punctures of the skin to be made, is described and illustrated. Wells discusses the results obtained and also the relative merits of B.C.G. vaccine and the vole bacillus vaccine. An evaluation of the results obtained can be made only by experts who have a wide experience of that kind of work. Those who are interested must read the report itself.

Dr. A. H. T. Robb-Smith's notes on the lesions produced by the vole bacillus and the excellent photographs of them with which he illustrates his notes are a worthy addition to the report. Everyone who is interested in the intricate problems presented by tuberculosis will be grateful for the inclusion in a single compact and well-written publication of so much information, together with the references to the literature which are relevant to it.

G. Lapage

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* Medical Research Council. Special Report Series, No. 259. The Murine Type of Tubercle Bacillus (The Vole Acid-Fast Bacillus) with Notes on the Morphology of Infection by the Vole Acid-Fast Bacillus. By A. H. T. Robb-Smith. Pp. iv+48+13 plates. (London: H.M. Stationery Office, 1946.) 2s. net.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 17

Royal Physical Society of Edinburgh (at the Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh), at 5.15 p.m.—Dr. D. O. Morgan: "The Liver Fluke".

Tuesday, November 18

British Psychological Society, Industrial Section (at the London School of Hygiene and Tropical Medicine (Room 105), Keppel Street, London, W.C.1), at 1.10 p.m.—Mr. Elliott Jaques: "Methods of Changing Group Behaviour".

Chadwick Public Lecture (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. G. A. R. Sheppard: "Modern Trends in Waterworks Practice" (Bossom Gift Lecture).*

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. J. G. Malloch: "Scientific Research in Canada and its Links with Science in the United Kingdom" (Neil Matheson McWharrie Lecture).

Society of Chemical Industry, Agriculture Group (in the Physical Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. R. S. Cahn: "The Role of Chemistry in Recent Developments of Animal Insecticides".*

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Rev. E. W. Smith: "The Ba-Ila Revisited".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "The Vegetation of the Chalk", 4, "The Woodlands of the Chalk".

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. G. C. L. Bertram: "Eugenics, Population Trends and the World's Resources".*

Physical Society, Low Temperature Group (joint meeting with the Chemical Engineering Group of the Society of Chemical Industry, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. P. M. Schuftan: "A New Process for the Recovery of Ethylene from Coke-Oven Gas".

Society of Dyers and Colourists, Scottish Section (at St. Enoch Hotel, Glasgow), at 7 p.m.—Dr. A. Landolt: "Improvement of the Properties of Fibres and Dyeings by Treatment with Hydrophobic Melamine-Formaldehyde Compounds".

Wednesday, November 19

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Ernest T. Fisk: "The Development of Sound Recording and Reproduction".

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.

Royal Microscopical Society (at B.M.A. House, Tavistock Square, London, W.C.1), at 5 p.m.—Communications on "Electron Microscope Studies of Tissues from High- and Low-Breast Cancer Strains of Mice" (to be introduced by Prof. R. D. Passey).

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the Wellcome Research Institution, 183 Euston Road, London, N.W.1), at 6.30 p.m.—Annual General Meeting.

Society of Dyers and Colourists, Midlands Section (at the Victoria Station Hotel, Nottingham), at 7 p.m.—Dr. E. S. Paice: "Petroleum Chemistry as applied to Textiles".

Thursday, November 20

Royal Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Symposium on "The Results of the Heligoland Explosion" (to be opened by Dr. E. C. Bullard, F.R.S.); at 4.30 p.m.—Special General Meeting to consider the Annual Report of Council.

Chemical Society (in the Chemistry Lecture Theatre, The University, Liverpool), at 4.30 p.m.—Prof. H. W. Melville, F.R.S.: "The Chemistry of Ethylenic Polymers".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—"Cross-Linking in Polymeric Systems" (other lectures on November 27, December 4 and 11).

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Report on "The Practical Training of Professional Electrical Engineers" (to be presented by Sir Arthur Fleming).

Chemical Society (joint meeting with the University College Scientific Society, in the University College, Hull), at 6 p.m.—Prof. A. C. Chibnall, F.R.S.: "The Structure of Proteins from the Viewpoint of the Chemist".

Women's Engineering Society, Manchester Branch (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. W. Bosley: "The Cyclotron and Betatron".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, November 21

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. J. Greig and Mr. H. Kayser: "Iron-Loss Measurement by A. C. Bridge and Calorimeter".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Sir Alwyn Crow: "The Rocket as a Weapon of War in the British Forces" (Thomas Hawksley Lecture).

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. G. Taylor: Streatfeild Memorial Lecture.

Society of Dyers and Colourists, Manchester Section (joint meeting with the Textile Institute, in the Gas Department Showrooms, Town Hall Extension, Manchester), at 7 p.m.—Mr. C. P. Tattersfield: "The Effect of Physical Pretreatment on the Ease of Saponification of Cellulose Acetate Rayons and Films".

Chemical Society (in the Royal Technical College, Glasgow), at 7.15 p.m.—Prof. M. G. Evans, F.R.S.: "Electron Transfer Reactions".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. H. Desch, F.R.S.: "Recent Developments in the Steel Industry".

Saturday, November 22

Royal Institute of Chemistry, London and South-Eastern Counties Section (at Brighton Technical College, Brighton), at 6 p.m.—Mr. J. G. N. Gaskin: "The Examination of Questioned Documents".

Thursday, November 20—Friday, November 21

Institute of Physics (joint meeting of the Midland Group and the X-Ray Analysis Group, in the Temple Room, Imperial Hotel, Birmingham).—Conference on "The Structure and Physical Properties of Metals".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Chemistry up to B.Sc. standard—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (November 22).

Principal Deputy Director and a Deputy Director (Research) in the Meteorological Office—The Under-Secretary of State, Air Ministry (S.2), Cornwall House, Waterloo Bridge Road, London, S.E.1 (November 30).

Lecturers in General Science, Geography, and Mathematics—The Secretary, University of London Institute of Education, Malet Street, London, W.C.1 (November 30).

Chair of Geography at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 1).

Assistant Director (Development) in the Department of Atomic Energy, Risley, Lancs—The Ministry of Labour and National Service, Technical and Scientific Register, Room 699, York House, Kingsway, London, W.C.2, quoting F.898/47A (December 2).

Chair of Botany at Queen Mary College, and the Hildred Carlile Chair of Botany at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 4).

Superintendent of the Engineering Division of the National Physical Laboratory in the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2034 (December 4).

Fuel Engineer to undertake the investigation of problems associated with the use of turf in domestic and industrial consumer appliances—The Secretary, Bord na Mona, 28–30 Upper Pembroke Street, Dublin (December 6).

Educational Psychologist—The Secretary, The University, Edmund Street, Birmingham 3 (December 6).

Senior Principal Scientific Officer in the Royal Naval Scientific Service (in the first instance as Superintendent of the Royal Naval Physiological Laboratory, Gosport)—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2025 (December 8).

Principal Scientific Officers or Senior Scientific Officers in the Ministry of Supply, (*a*) at Headquarters in London for handling research work connected with high temperature alloys and materials for use in gas turbines and other engines, (*b*) at the Royal Aircraft Establishment, Farnborough, to undertake research and development work on light alloys used in aircraft production—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2032 (December 9).

Deputy to the Scientific Adviser to the Army Council—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2026 (December 10).

Chemist in the Endocrine Unit—The House Governor, London Hospital, Whitechapel, London, E.1.

Physicist or Metallurgist with X-ray crystallographic experience, and a Metallurgist, for research on the surfaces of metals and coatings—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Senior Lecturer in Mathematics—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3.

Lecturer in Bacteriology—The Registrar, The University, Reading.

Mathematical Physicist for the Theoretical Physics Branch of the Research Division—The National Research Council, Atomic Energy Project, Chalk River, Ont., Canada, quoting File 9–F.

Organic Chemist, a Radio or Electronic Engineer, and a Technical Assistant for general laboratory work—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

Lecturer in Pharmacology—The Dean, College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

Research Assistant in the Pomology Department—The Director, John Innes Horticultural Institution, Merton, London, S.W.19.

Lecturer in Physical Chemistry to Honours Degree standard—The Registrar, College of Technology, The Newarke, Leicester.

Lecturer in Mathematics—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

Lecturer in Physiology—The Registrar, University College, Nottingham.

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MASS EDUCATION AND INTERNATIONAL UNDERSTANDING

THE discussion on the United Nations Educational, Scientific and Cultural Organisation which took place at the British Association meeting at Dundee attracted a very small audience; no doubt this was due in part to the fact that the meeting clashed with other important and topical discussions; but a more important reason is the general lack of knowledge of the activities of the Organisation. Sir John Maud, it is true, headed members of the British co-operating body, and expounded most ably the aims of the Organisation; he believes it should attempt to instruct the peoples of the world on the realities of the situation, so that they can understand better the causes of peace and war and thus make the politicians' task of direction easier. He sees its task as primarily that of helping people to learn that they need one another, and to deepen their sense of social responsibility, thus pursuing much the line of thought in more general terms that Mr. Henry Stimson follows in his article in *Foreign Affairs* on "The Challenge to Americans". Prof. F. J. M. Stratton dealt with the relations of the Organisation with the international scientific unions, and other speakers in the discussion indicated the wide range of fascinating subjects with which it is already concerned. Its major activities have since been reviewed in a progress report by Dr. W. H. C. Laves, the deputy director, in the *United Nations Weekly Bulletin*. Already some 72 million dollars' worth of material has been collected by voluntary agencies, chiefly in the United States, under the Temporary International Council for Educational Reconstruction, and fifty sets of laboratory equipment have been collected for consignment to forty-one selected laboratories in five countries. Technical needs in the fields of the Press, radio and films have been surveyed in some eight or ten war-devastated countries. It is expected that a conference at Nanking will encourage a pilot project on fundamental education, for which the Organisation will provide an adviser; and consultant-advisers for pilot projects in the same field are also to be provided for the Governments of Haiti and Nyasaland. The Organisation is also vitally concerned with mobilizing social scientists throughout the world for an inquiry into the tensions affecting international understanding, and a preliminary outline on this study has been distributed to nearly five hundred workers in this field in twenty-nine countries. Preparations are under way for a conference on the social sciences in 1948.

The Organisation also participated in the meetings of the United Nations Sub-Commission on Freedom of Information and of the Press, and has prepared for the Economic and Social Council a study of the shortage and unequal distribution of newsprint and of the bearing of this on the freedom of the Press. Material is being collected through national sources for world lists of films on international understanding, fundamental education, agriculture, health and popularization of science and the arts. An International Scientific Commission called by the Organisation and the Government of Brazil, which met in Belem in September, discussed the establishment of an Institute of Hylean Research (see *Nature*, Sept. 27, p. 427).

A temporary science co-operation office has been set up in Rio de Janeiro and steps taken to establish an office in the Middle East. A third office, in the Far East, is being established this autumn. Several grants-in-aid have been made to scientific international bodies which are members of the International Council of Scientific Unions. The copyright problem is also being tackled, and assistance has been given in the award of fellowships provided by member States and organisations such as the American Chemical Society for the exchange of qualified personnel.

That the United Nations Educational, Scientific and Cultural Organisation may in such ways as this render great service to science is not to be doubted. The primary ideal on which the Organisation was founded—the free flow of ideas among men—is at the root of scientific advance also. But it should be recognized also that while the Organisation derived much of its original shape and confidence from the intellectuals of Europe, with the new morale among professional men and the clearer understanding of the political power inherent in cultural affairs which the experience of the War gave them, the real leverage of the Organisation in whatever it does must be the power of public opinion; and as Mr. Byron Dexter observes in *Foreign Affairs* (**25**, 388; 1947) the two requirements for the effective application of that force are technical efficiency and unremitting attention to the business in hand.

Dr. Laves' progress report gives promise that the director-general and his staff do, in fact, embody these virtues as they are designed to do, but neither his report nor the discussion at Dundee came to grips with the real issue that confronts the Organisation—the firm rejection by the U.S.S.R. of that primary freedom of information which is an inseparable part of freedom of speech and expression. Mr. Ritchie Calder, it is true, dealt at Dundee with the problem of securing the interest and support of the two thousand million peoples in the world, and maintained that this is only possible through the media of mass communication. The instruments of mass communication, though effective, can be very dangerous; and Mr. Calder estimated that if the Organisation were to have its own newspaper, film-studios and broadcasting stations, it would need an income of a billion dollars a year.

While that would appear to be outside the range of possibility for a considerable time to come, even if it be accepted as necessary or desirable, on the cultural side there are much more hopeful signs than in the political and economic field. The series of international conferences in so many branches of science, and other intellectual activity during the present year, bear witness to a remarkable yearning to override national frontiers, to confer and compare experience. A deep thirst for books and periodicals, for the exchange of dramatic works, films and music is evident to any traveller in Western or Eastern Europe. Mr. Kenneth Lindsay notes in *The Manchester Guardian* that most of those concerned in the rebuilding of European education and culture are anxious to leave political views in abeyance and to resume their specialist studies and scholarship in order to catch up with the last years of research and reading.

Mr. Lindsay points out that besides the old-established international societies reviving their work, there has been a wholly new set of conferences, designed to establish new societies, to build new bridges, and to weave new patterns of thought and culture. His travels have indicated that the vicissitudes of war have given even greater confidence in the values of European civilization and freedom of learning, while shaking the hold of political dogmas. In each country he found the same basic questions being faced: the preservation of standards in secondary schools; the proper approach to youth; the status, pay and freedom of the teacher; the quality of the administrator; the definition and function of a university in the twentieth century; and the supreme importance of adult education and democracy.

Admittedly, education has not kept pace with scientific, political and economic development. Except in one or two areas, the social sciences are backward all over Europe. But while reconstruction work is under way and the British Council, and more recently U.N.E.S.C.O., have repaired some deficiencies by sending technicians and specialists to British universities and Swiss and Swedish technical colleges, Mr. Lindsay pleads eloquently for fresh inspiration and leadership in the universities and among those who form the minds of the growing generation. It is the absence at the present time of European leadership, apart from a small group of thinkers and writers who can only meet each other with considerable difficulty, that Mr. Lindsay regards as the most sinister feature.

Is it possible that the United Nations Educational, Scientific and Cultural Organisation could meet this need, and at the same time boldly take up the challenge represented by Russian rejection of three out of the four freedoms of Franklin Roosevelt? The political and economic organs of the United Nations will not function effectively unless they are matched by the acceptance of some common values—values expressed in general terms which permeate the schools and universities, and above all those million undergraduates in European universities who are destined to influence so largely the next decades of European history. If the Organisation is wise enough to eschew undertakings such as the revision of text-books, which though admirable in theory are likely to prove sterile in practice and merely controversial, and to concentrate on fields such as mass education, the reconstruction of education in Europe, and scientific projects such as the exploration of the resources of the Hylean Amazon, it may do two things. It may secure the widespread support and understanding it needs for success, and doing so it may demonstrate that an edifice built on the four great pillars of freedom of speech and expression, freedom of religion, freedom from fear and freedom from want is more secure, spacious and satisfying than one based solely on the banishment of want.

There can be no more hopeful way of inducing those who remain outside U.N.E.S.C.O. to use the freedom and the shelter it offers and of thus at last creating one world community; but to succeed in this it is necessary to remember, as Mr. Ritchie Calder has pointed out, that the purpose of the Organisation lies not with the pedants, but with the peoples of the world. It may assist scientific workers, for example, to maintain the unrestricted pursuit of objective truth and the free exchange of ideas and knowledge; but the first duty of the Organisation is not in any such narrow or limited field. It is "to collaborate in the work of advancing mutual knowledge and understanding of peoples, through all means of mass communication"; not merely to increase and improve the means of communication between the thirty-five nations that have accepted the principles defined in the preamble of the Charter, but to use these means for the purpose of mutual understanding, and a true and more perfect knowledge of each others' lives. The measure of achievement of the United Nations Educational, Scientific and Cultural Organisation will depend not merely on the extent to which it enlists the support of men of science and other specialists, but above all on its success in discovering the idioms of the ordinary people and interpreting to them its aims, its plans and its achievements.

A DEVELOPMENT PLAN FOR UGANDA

A Development Plan for Uganda
By E. B. Worthington. Pp. xii+112. (Entebbe: Government Press, 1946.) 2*s*. 6*d*.

In no part of Britain's tropical empire is research into the available agricultural and commercial possibilities more likely to reward the investment of capital and labour than in the Uganda Protectorate. Focal position within Africa, easily manageable size, reliability of rainfall, and—by African standards—a fair degree of soil fertility are among its physical assets; while, in regard to the availability of suitable labour, the intelligence and aptitude of its Bantu and Hamitic communities are well esteemed.

It was inevitable, no doubt, because of the nature of Dr. Worthington's report, based as it is on a comprehensive yet highly summarized statement of the physical resources of the Protectorate, that little space could be spared for mention of the native population upon whose willing, if not enthusiastic, co-operation the project depends. The experience of forced labour for public works is not unknown in East Africa, but it is disappointing that, even before the native response has been tested, the probable need to apply conscription is foretold. A favourable voluntary response from the Baganda, Basoga and other peoples—so very desirable in the interest of the success of the plan, if for no other reason—would largely depend on the moral as well as material incentives which were laid before them. Moreover, the communities of Uganda vary so much between themselves in their traditions and skills that the significance of these factors from the point of view of the plan must be investigated very early. The absence from the report of considerable reference to distinctions between one native community and another suggests the hope that a separate report to include such matters may soon be possible. Estimates of the population (3,956,700 in 1944) show an increase of rather less than two millions since 1911. Here, in the region of the upper Nile, there is no land-hunger comparable with that of Egypt, and it is possible to plan economic development free from pressing anxiety. It is confidently predicted that the population of Uganda will attain ten millions before the end of the century, although the influence of such serious checks on increase as have occurred during the last thirty years should not be under-estimated.

Dr. Worthington's proposals seem to be in harmony with the official view that peasant agriculture must remain the basis of Uganda's economy for a long time to come, even though, in the opinion of the Governor of Uganda, who contributes a foreword, the introduction of European-owned estates and concessions would offer greater prosperity to the Protectorate. The raising of the standard of life can be achieved only by a progressive increase in the productivity of the soil, and the author, offering a warning against a possible dissipation of effort and funds, proposes for the immediate future with which his plan is concerned concentration upon certain experimental projects, known as "pilot schemes", in selected areas. The first of these is to be in South Busoga, at one time known as the "garden of Uganda", along fifty miles of the shore of Lake Victoria between Jinja and Mjanji.

There is a difference in objective between the pilot schemes, as proposed for Uganda, and the well-known groundnut scheme which has been devised for the agricultural betterment of British territories farther to the south in East Africa. The main purpose of the latter scheme, which is intended only for sparsely populated districts, is maximum production of an export crop with the minimum of trouble and with the minimum of native labour, but with a comparatively high proportion of white employees. On the other hand, the pilot schemes of Uganda are intended for the advancement of the standard of life in a comparatively well-populated protectorate, while they both anticipate and encourage the highest density of population which is compatible with efficiency. It is expected that each pilot scheme will involve about £1 million over ten years, with European to African employees in the ratio of about 6 : 6,000.

In its various scientific services Uganda, in common with neighbouring British territories, requires generous expansion; and in meteorology, hydrology, etc., suitable recommendations are made, including the request for the preparation of an atlas of Uganda. For this last-mentioned enterprise the model might well be the "Atlas du Katanga", the first maps of which were published many years ago by the Belgian Government of the Congo.

Tsetse control is perhaps the most urgent of needs, and the widespread invasion of Uganda by fly demands the establishment of a tsetse control department which would plan attacks on the pest from strategic points. The policy of protection, improvement and development of natural resources, with its inevitable emphasis on agriculture, fully justifies the proposed expansion of the Agricultural Department and the foundation of a chair of agriculture at

Makerere College. The expansion of the Uganda Museum is another project of importance to both research and education, and will be concerned both with ethnology along lines already well established and with the evolving life of the native communities.

Every aspect of public service, such as transport and hydro-electric power, receives attention. The scarcity of coal and other fuels necessitates the utilization of the water resources, particularly Lake Victoria, Africa's greatest reservoir. A scheme involving control of the lake-level would provide an ample margin of power, over and above the demand foreseeable within the next ten years.

The maps which accompany the report are well selected, but their uniform scale is too small for the detail of the various distributions shown, and legibility is not always guaranteed.

WALTER FITZGERALD

THORPE'S DICTIONARY

Thorpe's Dictionary of Applied Chemistry

Fourth edition, revised and enlarged. Vol. 8: Meths-Oils, Essential. Pp. viii + 679. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 80*s*. net.

THERE can surely be few works of reference which provide so rich a harvest of knowledge as this latest volume, just issued, of Thorpe's "Dictionary of Applied Chemistry". Many of the writers are not only experts in their special fields of interest but are also active workers engaged in the promotion and extension of this knowledge. The impression gained by reading many of the articles written by distinguished authors is that no chemist, whether in the academic or industrial field, can venture far in his subject without having this volume for reference.

The subjects comprised under the titles from "Meths-Oils, Essential" include a mass of general topics of more than ordinary interest in present times. There are also others to which one would go for a fundamental and historical background of subjects of more common interest.

Prof. E. F. Burton of Toronto writes on the electron microscope, Dr. G. B. B. M. Sutherland on infra-red and Raman spectra, and Prof. R. A. Morton on visible and ultra-violet molecular spectra. These articles give a conspectus of present knowledge and of the methods of investigation in these fields. The editors are to be congratulated on having secured, shortly before his death, a valuable article from that veteran, Prof. V. M. Goldschmidt, on geochemistry of minerals. Minerals and X-ray analysis are ably dealt with by Dr. F. A. Bannister of the British Museum (Natural History), and Dr. L. J. Spencer contributes other articles on minerals. Dr. L. E. Sutton, of Oxford, has written on electric dipole moments. Prof. J. R. Partington has contributed the article on nitrogen and the utilization of atmospheric nitrogen, and Prof. J. H. Quastel has dealt with biological nitrogen fixation. Nucleic acids are ably discussed by the late Prof. J. M. Gulland and G. R. Barker, and there is included an article by Dr. C. J. G. Knight on growth factors for micro-organisms, a subject of current interest in view of the manufacture of biosynthetic products.

An authoritative article on octane number is contributed by Mr. F. L. Garton of the Shell Petroleum Co. and another by Dr. J. H. Burgoyne on methane as fuel. Micro-chemistry in most of its aspects is dealt with in great detail, including micro-chemical operations and drop reactions and organic micro-analysis. The major contribution to this volume is that by Dr. E. H. Rodd and his collaborators on naphthalene, which covers this field and provides an important monograph in itself and occupies 176 pages.

Generally the standard of the articles is high and the space allotted to each subject adequate, in some cases amply so for a chemical dictionary. Care has been exercised in the selection of contributors, and in many cases these are men of front rank. Where a large field must be covered in limited space, as in the article on high-vacuum distillation (molecular distillation) by Dr. K. C. D. Hickman of Rochester, N.Y., an exhaustive bibliography accompanies the article. A noteworthy contribution is one on molecular beams by Prof. O. R. Frisch of Cambridge.

The volume is well presented on good paper with sufficient margins and a sturdy binding.

NORMAN HAWORTH

QUALITATIVE QUANTA

The Strange Story of the Quantum

An Account for the General Reader of the Growth of the Ideas underlying our Present Atomic Knowledge. By Banesh Hoffmann. Pp. xi+239. (New York and London: Harper and Brothers, 1947.) 3 dollars.

IT is perhaps ungrateful to begin the review of this delightful book with a complaint, but it is surely unnecessary to state Planck's constant on p. 22 as a pure number. Apart from this, the reviewer must add that no book of popular science since 'Mr. Tompkins'' exploration of the atom has given him such keen pleasure in the reading.

The object of the book is to give for the benefit of the general reader as complete an account of the development of modern quantum theory as is possible without the use of mathematical symbolism. Dr. Hoffmann's general reader, however, must be gifted with an uncommon degree of intelligence and mental agility if he is to derive any clear idea of the developments after 1925 of the theory from a first reading of this book. The author's method of presentation reminds one of a man with a club hewing his way through a hostile mob. The historical development is followed quite accurately, and as each point arises, the probable consequent misconceptions are mustered, presented in their most formidably persuasive form, and then, in the next paragraph, down comes the club. They are knocked on the head and dropped in the gutter, and Dr. Hoffmann advances triumphantly, with the reader, a little breathless and apprehensive, tugged along in his wake. This is showmanship in the grand style, but there is no sacrifice of accuracy in the physics for its sake.

"The Strange Story of the Quantum" succeeds above all in showing that science is no static dry-as-dust body of knowledge. The author's quick-moving style recreates the excitement of the mid-1920's when quantum theory was beginning to assume its modern form. He makes it clear how successive ideas came into contradiction with experience and were replaced, and he emphasizes the precarious state of the present-day physics, with relativity and quantum theory uneasy bedfellows. The pages carry a foam of witty remarks (some of which are not too easy for the non-American to understand), and it is not the least commendable point of the book that Dr. Hoffmann, perhaps because he is a mathematician rather than a physicist, is not deterred by professional solemnity from making it clear beyond any doubt that 'physics is fun', a truth well known but too rarely expressed.

G. WYLLIE

BRITISH DIVING BIRDS

Haunts of British Divers

By Niall Rankin. Pp. 96 + 83 plates. (London: Wm. Collins, Sons and Co., Ltd., 1947.) 12s. 6d. net.

THE series of beautiful books which are being issued under the title of "The New Naturalist" receives a most welcome addition in the present volume, devoted to the account of three birds, the great crested grebe, the black-throated diver, and the red-throated diver.

Colonel Rankin, who owns the famous sanctuary on the Isles of Treshnish in the Hebrides, is not only a keen naturalist but also a first-class photographer. The result is a graphic picture of one of England's most attractive water-fowl, and two of Scotland's lesser known birds in the Highlands and Hebrides, accompanied by striking views of the romantic country in which they occur.

The account of the great crested grebe occupies the first half of the book, and is based on observations on a favourite home of these birds, a large tree-fringed lake in Kent, where eight or nine pairs regularly breed and many spend the whole year without migrating. The breeding and nesting habits are described in detail. Special mention should be made of the striking series of photographs showing the feeding of the chicks, and in particular the peculiar habit of each parent of plucking feathers from its own breast and feeding them to its offspring.

The black-throated diver does not breed south of north Perthshire and Argyll, but becomes commoner to the north, although it is not known to nest in the Orkneys and Shetlands. A remote loch in Sutherland provided the material for this study, based on a single pair of these handsome birds. The red-throated diver, a circumpolar species, has a more northerly distribution, and is comparatively common in the Orkneys and Shetlands. The author selected the island of Unst, to the extreme north of the Shetlands, for the study of this species, and also took the opportunity of making observations and illustrations of the sea-birds so abundant in that area. The curious breeding behaviour of the red-throated diver, including the position created when the duty-bird on a nest was approached by three other divers, including the 'other half' belonging to this nest, presents an interesting problem in animal psychology.

The author, in his introduction, modestly states that he offers nothing new to ornithology. Whatever the truth of this statement, he offers the reader the personal observations of a keen observer accompanied by excellent photographs, which constitute a valuable addition to our knowledge of bird behaviour, and will be welcomed by all naturalists.

In addition to the eighty-four photographs by the author, special mention should be made of the coloured frontispiece and eleven pen-and-ink drawings by Margaret Myddelton.

E. HINDLE

A NATURALIST'S NOTES

Highland Naturalist Again

A Gamekeeper's Observations and Discoveries. By Dugald Macintyre. Pp. 220 + 8 plates. (London: Seeley, Service and Co., Ltd., n.d.) 15s. net.

DUGALD MACINTYRE, during his long life spent in observing living creatures, has amassed a store of knowledge of the wild life of the Scottish Highlands equalled by few. In this, his latest book, he discourses on seal and hare, ptarmigan and capercaillie, gull and jackdaw, and a host of other creatures. He has a good word to say for the rook, for in spite of its misdeeds in eating grain and potatoes it is the farmer's friend in spring. Let me quote Mr. Macintyre (p. 133): "Billions of leather-jackets, which are the farmer's worst insect enemies, were taken from the fields of young oats and barley and wheat by the foraging rooks. Crops grown near the rookery grew well in bad years for 'grub', when crops too distant for the rooks to reach were destroyed almost to the last blade. There was one big farm many miles from the nearest rookery and rooks were never seen on that farm, so the crops suffered much from grub."

He describes an osprey fishing on Loch Awe in winter. That, surely, must be a very rare occurrence, for the osprey, when it nested in the Highlands, was a summer visitor only, and now that it nests with us no longer it is seen on spring and autumn migration, to and from its haunts in Central Europe.

Were Mr. Macintyre a less competent observer his statement (p. 166) that: ". . . while the loch [Loch Awe] remained wholly free from frost, but when its shallows were frozen over, the osprey was driven inland, and necessity compelled him to take other food than fish. The gamekeeper found him one day making a meal of a grouse, far inland from the loch: on another snowy day a wild-fowler of Loch Etive saw him pursue and take a wounded widgeon" would be received with at the least grave doubts, for at the season when the Loch Awe shallows freeze the osprey is normally basking in the warmth of the African sun.

On p. 162 Mr. Macintyre mentions that the Scottish capercaillie became extinct about the middle of the eighteenth century, and that the present stock is descended from birds introduced from Sweden. He makes the interesting suggestion that the birds are susceptible to disease, and that for this reason the stocks in certain districts are again decreasing fast.

The felling of great areas of Scots pine during the war years, a felling which still continues, has been injurious to the capercaillie, and the bird is also killed on all land of the Forestry Commission, on account of its habit of destroying the tender leading shoots of conifers. It would be regrettable if the caper were to die out a second time, for it is a noble bird, and adds charm to the dark miles of the old Caledonian Forest, where its cousin, the black grouse, has also become much scarcer during the last score of years.

The publishers of "Highland Naturalist Again" are to be congratulated on the printing of the book, and its excellent paper, in these days of restrictions and difficulties: there are several excellent illustrations, supplied by leading Nature photographers.

SETON GORDON

JAMES HUTTON (1726-97) AND SIR CHARLES LYELL (1797-1875)

By V. A. EYLES

H.M. Geological Survey of Great Britain

THIS year, the hundred and fiftieth anniversary of the death of James Hutton, who has justly been styled the 'father of modern geology', has been made the occasion for a number of commemorative meetings in Scotland, the land of his birth. Addresses have been delivered to the Geological Societies of Edinburgh and Glasgow; and, on November 3, at a special meeting of the Royal Society of Edinburgh, Sir Edward Bailey read a paper on the "Life and Work of Hutton" [see p. 727]. On the same day the Lord Provost of Edinburgh unveiled a memorial tablet in Greyfriars Churchyard. This plaque was appropriately cut from granite, the igneous origin of which was first demonstrated by Hutton; and it was placed close to his hitherto unmarked grave.

It is, of course, especially fitting that such a celebration should have been arranged by the Royal Society of Edinburgh, because the first account of Hutton's famous theory of the earth was read to the members of that Society in 1785, and published in the first volume of the Society's *Transactions* in 1788[1].

Hutton was deeply interested in many branches of knowledge, particularly chemistry and agriculture; but his claim to fame rests on his contributions to the science of geology. These were finally embodied in full in his two-volume "Theory of the Earth with Proofs and Illustrations", published in Edinburgh in 1795. Some further parts of the "Theory", which remained in manuscript form for many years, in the possession of the Geological Society of London, were published by that Society in 1899, as Volume 3 of the "Theory".

Unlike many earlier theories of the earth, such as that of Burnet, and others of the 'physico-theological' school, as it has been termed, a number of which were published in the latter part of the seventeenth and during the eighteenth century, Hutton's theory in its final form was firmly based on deductions made from first-hand observations of the rocks themselves. These he had carried out for many years, often accompanied by friends with whom he discussed his ideas. He also entered into frequent debates, in Edinburgh, with other prominent Scottish men of science, notably Black, the chemist. He read, too, much of the contemporary literature that was relevant to his researches, and this, no doubt, influenced his ideas. Finally, in reaching his conclusions, he was not deterred, as were so many previous writers (and indeed later authors), by the knowledge that his ideas ran counter to the doctrines of the established church.

In spite of the manifest truths, as they now seem to us, that were contained in Hutton's great work, his conclusions met with much opposition, and it was many years before they obtained full recognition. Various causes contributed to this delay. Chief among them was the influence of Werner, whose doctrines, for the most part completely at variance with those of Hutton, were widely accepted at that time and for some years afterwards, not only on the Continent, but in Great Britain also. A contributory cause was that Hutton's style was so obscure and difficult to follow that it may well have prevented some readers from fully apprehending his theories; and, in any event, it seems that his book became so scarce within a few years of his death that it may have been inaccessible to some geologists. Fortunately, a re-statement of the Huttonian doctrines, written in a clear and elegant style, appeared in 1802. This was the "Illustrations of the Huttonian Theory of the Earth", written by Hutton's intimate friend, John Playfair. It was widely read and almost certainly more effective than Hutton's own book in spreading the latter's ideas.

Shortly after Hutton's death, Playfair wrote a biographical account of his friend. Little that is new has since been published about Hutton the man[2]; but during the past hundred and fifty years a number of competent authors have analysed his work[3]. The grain has been sifted from the chaff, and the debt that their science owes to the patient labours of Hutton has been made clear to modern geologists. His contributions to geological thought are now too well-known to need particularizing here.

It is, however, worth recalling that the year of Hutton's death, 1797, is also memorable as the year in which another almost equally distinguished Scottish geologist, Sir Charles Lyell, Bart., was born; particularly because Lyell, probably more than any other, was instrumental in securing the general acceptance, in Great Britain, of the teachings of Hutton. This he did through the medium of his classic, "Principles of Geology", which, first issued in 1830–33, in three volumes, went through twelve editions in the succeeding forty-five years, and was also published in the United States. It was said of Lyell by Sir Andrew Ramsay, "We collect the data and Lyell teaches us to comprehend the meaning of them". Though chiefly distinguished as a critic and writer on the researches of his forerunners and contemporaries, Lyell was no mere armchair geologist and compiler of text-books. He travelled widely both in Britain and abroad, and during his travels widened his ideas, not only by geological field-work, but also by contacts with leading foreign geologists.

When, ultimately, Lyell's matured views were published in the "Principles", he acknowledged his debt to Hutton by inserting at the beginning of Volumes 1 and 2 of the first edition, quotations from Playfair's "Illustrations". In addition, in the historical introduction that occupies the first five chapters of his work, he discusses Hutton's "Theory" against the background of geological ideas that were current when it was published. In spite of this, he was criticized by a contemporary, W. H. Fitton, for not giving due weight in this summary of the history of geology to the importance of Hutton. Writing in the *Edinburgh Review*, in 1839[4], Fitton stated, in reference to Lyell's "Principles", "We think that Mr. Lyell has not, either in his preliminary history or in the body of his works, done quite sufficient justice to the claims of Dr. Hutton—whom we conceive to be effectively the author of the Theory of the Earth now most universally received; . . . This defective appreciation of Hutton we have no doubt may be ascribed, in a great measure, to the direction given by accidental causes to Mr. Lyell's own pursuits; but it is the more unfortunate, as the public and the general reader will naturally make a work so popular as the 'Principles of Geology' their text-book and authority; while many eminent men, engaged in the cultivation of other departments of physical science will be content to take their impression from the clear and fluent pages of that publication; with some indifference, perhaps, as to the relative merit of those by whom geology has been advanced to its present state."

Lyell received Fitton's review while staying at his father's house at Kinnordy, Angus, and at once replied to the reviewer in a long and interesting letter[5], in which he defends himself from the charge of neglecting to give Hutton his due. The following paragraphs are of particular interest. In referring to Hutton's "Theory", Lyell states: ". . . I found it difficult to read and remember Hutton, and though I tried, I doubt whether I ever fairly read more than half his writings, and skimmed the rest"; and he also records that "The mottos of my first two volumes were especially selected from Playfair's Huttonian Theory, because although I was brought round slowly, against some of my early prejudices, to adopt Playfair's doctrines to the full extent, I was desirous to acknowledge his and Hutton's priority, and I have a letter of Basil Hall's [son of Sir James Hall, intimate friend and supporter of Hutton] in which . . . he comments on the manner in which my very title-page did homage to the Huttonians, and complimented me for thus disavowing all pretensions to be the originator of the theory of the adequacy of modern causes".

In the last part of the letter Lyell writes: "It was my business, in tracing the progress of our science to its present state, to estimate the importance of each writer, and adjust the quantity of space due to him in my historical sketch, not simply according to his originality and genius, but partly at least in proportion to his influence; and I still think that Werner's eloquence, popularity, enthusiasm, and position at Freyberg, placed him in this point of view as much above Hutton as I have represented him to fall below him in reference to the truth of his theories. Yet as an admirer of Hutton all I could have wished is, that your panegyric on Hutton had appeared as aiding and seconding my efforts, since I trust that no book has made the claims of Hutton better known on the Continent of late years than mine".

Lyell is, of course, correct in stating that the influence of Hutton on geological thought during the latter's life-time, and for some years after, was small compared with that of Werner, both in Britain and abroad. By the time the first volume of the "Principles" was published, the influence of the Neptunists, as Werner's followers were called, was definitely on the wane in Britain; but there were still a few 'die-hards' among the more prominent geologists who, though perhaps no longer subscribers to the doctrines of Werner, were yet reluctant to swallow Hutton's teachings in their entirety. Such a one was Adam Sedgwick, professor of geology at Cambridge and president of the Geological Society of London, who attacked Lyell in a presidential address to the latter Society, in 1831, as being, in the "Principles", "the champion of a great leading doctrine of the Huttonian hypothesis"[6]. Lyell's claim, too, that his book influenced continental geologists appears to be well founded. The "Principles" was translated into French and German, and Zittel, in his "History of Geology"[7], states, "In Germany . . . Lyell's works attained immediate celebrity and were made widely known by several translations". In this connexion, however, it should not be overlooked that a French translation of Playfair's "Illustrations" had been published in Paris in 1815[8].

Whether or not Lyell fully appreciated, at the time he wrote the "Principles", the fundamental importance of Hutton's theories, upon which a very large part of the superstructure of modern geology now rests, the judgment of posterity leaves us in no doubt regarding the eminence, not only of Hutton, but also of Lyell himself. Our debt to these two masters has been admirably expressed by Sir Archibald Geikie in his "Founders of Geology": of Hutton he wrote: "The dominant idea in his philosophy is that the present is the key to the past. We have grown so familiar with this idea, it enters so intimately into all our conceptions in regard to geological questions, that we do not readily realize the genius of the man who first grasped it with unerring instinct, and made it the chief cornerstone of modern geology"[9]; and of Lyell he asserted: "But of the English writers of general treatises of geology, the first place must undoubtedly be assigned to Charles Lyell who exercised a profound influence on the geology of his time in all English-speaking countries. Adopting the principles of the Huttonian theory, he developed them until the original enunciator of them was nearly lost sight of. With unwearied industry he marshalled in admirable order all the observations that he could collect in support of the doctrine that the present is the key to the past"[10] . . .

In conclusion, one cannot do better than quote the opinions of the late Sir John Flett; of Hutton's "Theory" he says it was "at once supremely original and perfectly conclusive"[11]; and, referring to Lyell, he states, "By his easy, liquid style, his transparent sincerity, his profound knowledge of the literature and his judicial sense of the value of evidence, Lyell takes the highest place among the expounders of geological science. His work is the greatest and most famous classic in the literature of the subject. To him also we owe the conversion of Charles Darwin, while still a young man, to the orthodox theories of geology. Before Lyell's time scientific geology was already current and widely accepted, though there were still unconverted adherents of the older schools. But Lyell made the subject intelligible to all, so that he who runs may read. Darwin in his journals has recorded the profound impression made on his mind by the first reading of the 'Principles of Geology'. The science had emerged from the mists and obscurity of the cataclysmic school and the Wernerians, and was founded on the sure basis of observation interpreted in the light of the processes operating in the world around us at the present day."[12]

[1] Hutton, J., "Theory of the Earth; or an Investigation of the Laws Observable in the Composition, Dissolution, and Restoration of Land upon the Globe", *Trans. Roy. Soc. Edin.*, **1**, (Pt. ii), 209 (1788).

[2] New information has been collected by Mr. R. J. B. Munro, assistant librarian of the Royal Society of Edinburgh, which, it is hoped, may be incorporated in due course in a Hutton memorial volume that is projected by the Royal Society of Edinburgh.

[3] Notably, Fitton, W. H., "A Review of Mr. Lyell's 'Elements of Geology'; with Observations on the Progress of the Huttonian Theory of the Earth", *Edin. Rev.*, **69**, 406 (1839); Geikie, Sir A., "Founders of Geology", 2nd edit., 1905, Chap. 9; Bailey, E. B., and Tait, D., article "Geology" in "Edinburgh's Place in Scientific Progress", 63 (Edinburgh, 1921); Bailey, E. B., in "The Interpretation of Scottish Scenery", *Scot. Geog. Mag.*, **50**, 308 (1934); Macgregor, M., "James Hutton, the Founder of Modern Geology: 1726–97", *Endeavour*, **6**, 109 (1947); Clow, A., and Clow, Nan L., "Dr. James Hutton and the Manufacture of Sal Ammoniac", *Nature*, **159**, 425 (1947).

[4] Fitton, W. H., *loc. cit.*, p. 411.

[5] Lyell, Mrs., "Life, Letters and Journals of Sir Charles Lyell, Bart.", **2**, 47 (1881).

[6] Sedgwick, A., *Proc. Geol. Soc. London*, **1**, 303 (1834).

[7] von Zittel, K. A., "History of Geology and Palæontology", 196 (trans. by M. M. Ogilvie-Gordon, London, 1901).

[8] Playfair, J., "Explication sur la Théorie de la Terre par Hutton" (traduit et accompagné de Notes, par C. A. Basset, 1815).

[9] Geikie, A., *op. cit.*, 299.

[10] Geikie, A., *op. cit.*, 403.

[11] Flett, Sir John, "The First Hundred Years of the Geological Survey of Great Britain", 12 (1937).

[12] Flett, Sir John, *op. cit.*, p. 13.

MECHANICAL PROPERTIES OF METALS

CONFERENCE AT BRISTOL

A SUMMER school and conference on the mechanical properties of metals was held at the University of Bristol during July 2–9. At the summer, school (July 2–5) a course of lectures was given by Prof. N. F. Mott, Mr. F. R. N. Nabarro and some of their colleagues on the theory of the subject, especially on dislocations, plastic flow and precipitation. During the conference, papers mainly on experimental topics were given by physicists from various countries, including Meijering (oxidation hardening), Weil (ordered state in alloys), Druyvesteyn (mechanical properties at low temperatures), Andrade, Orowan, Chalmers, Cottrell (creep), Shockley (slip planes in silver halides), Lacombe (crystal boundaries), W. G. Burgers (recovery and recrystallization), Crussard (diffusion studied by thermo-electric methods), Guinier (precipitation), Snoek (elastic after-effects in iron), Guillet (internal friction), McKee and Leadbeater (powders).

Some of this work has already appeared in scientific journals, and many of the papers will be published in a special number of the *Proceedings of the Physical Society*; in this article it seems, therefore, more useful to pick out some salient points from the conference rather than to attempt a report on each paper.

Creep and Plastic Flow

From the experimental side a clear distinction was made by nearly all speakers between 'transient' and 'viscous' creep. Transient creep occurs when a metal, either a single crystal or a polycrystalline specimen, is stressed beyond the elastic limit; after an initial instantaneous extension the rate of strain $\dot{s}$ drops rapidly with increasing time t. Andrade[1] in his pioneering work on the subject gave for polycrystalline metals the formula

$$\dot{s} = \beta t^{1/3},$$

which can be derived from

$$\dot{s} = \text{const}/s^2.$$

In more recent work[2] on cadmium, he suggests for the flow of single crystals

$$\dot{s} = Ae^{c/s}.$$

Orowan more recently[3] has put forward the formula

$$\dot{s} = \frac{\text{const}}{s^2} \exp(-\alpha s^2/kT),$$

where the constants depend on the stress and temperature. It is characteristic of transient creep that: (*a*) it is a phenomenon taking place in single crystals or within the grains of polycrystalline materials; (*b*) it always takes place, even at quite low temperatures, following an instantaneous deformation of the material by any stress exceeding the elastic limit.

Viscous creep is the term given to the ultimate steady rate of creep which is obtained in certain cases. The term 'viscous' is slightly misleading, since, of course, the creep-rate is proportional to a high power of the stress. According to Andrade, in the early stages of creep there is rotation of the crystallites, accompanied by glide on crystal planes, but the final stages of true viscous creep in polycrystalline materials take place in a narrow zone surrounding the crystal boundaries, there being no deformation of the crystals as a whole at this stage.

In trying to understand creep, one has first of all fairly clear evidence that slip of one crystal boundary over another can occur and is a truly viscous process, the rate being proportional to the stress. A recent paper[4] from Zener's school in Chicago has used measurements of internal damping and other anelastic effects in pure polycrystalline aluminium to obtain a figure for the rate of slip at the grain boundary in this metal. The result is

$$\text{Rate of slip} = \text{stress} \times 5 \times 10^8 e^{-17,250/T} \text{ cm./sec.}$$

Of course, unless the grain boundary is flat (or of constant radius of curvature), any slip along the boundary will set up elastic strains near the surface of the grains; these strains are probably the cause of intercrystalline failure in creep tests in lead and other metals. Viscous creep possibly has its origin also in this grain boundary slip, which for large values of the applied stress will proceed until deformation takes place in the protuberances of the grain surface which lock the grains together. (This seems to be in accord with the observations of W. A. Wood and H. J. Tapsell[5], who find that a specimen of aluminium extended 0·9 per cent at 300° C. in a creep test shows little deformation of the reflexion spots from the grains; while, after a rapid deformation followed by heat treatment at 300° C. for an equal time, the deformation is much greater. They deduce that in the former case slip is mainly along grain boundaries; in the latter, deformation of the whole crystal occurs.) Since the stresses involved in grain-boundary slip can reach values much greater than the applied stress, one may expect deformation of the boundary region to occur until recovery or recrystallization sets in. The steady creep-rate, then, will be reached when hardening and recovery in the boundary regions just balance each other, and any quantitative theory must await a theory of these processes.

For transient creep, the elements of a theory are beginning to appear, based on the concept of dislocations. In any theory of this type, one has first to ask: Is the resistance to deformation shown by actual materials due to the difficulty of forming dislocations, or to the difficulty in moving them? The obvious fact that hardness increases with all kinds of internal strains and impurities suggests that the latter is the case. The source of dislocations remains something of a mystery; grain boundaries and mosaic boundaries (which can probably be represented as rows of dislocations) are possible sources, and, in slip bands, dislocations which have been set into rapid motion almost certainly generate others. However, for considerations of transient creep, it is probably adequate to consider that enough dislocations exist already.

One then ascribes the resistance to yield of any material to the internal stresses σ_i which exist in a material due to grain boundaries, precipitates or 'stuck dislocations'. These will prevent the motion of dislocations unless the applied stress σ exceeds σ_i. In this, one follows G. I. Taylor's theory of strain hardening[6]; but, as emphasized by the present writer, the deformation of single crystals, which harden rapidly, is theoretically a much more complicated problem than the deformation of hard materials (for example, precipitation-hardened alloys); in a hard material, investigations of creep or deformation will give information about the motion of dislocations under internal and external stresses which remain constant during the experiment.

According to the theory of Becker and Orowan, the energy of activation required to move a dislocation from one position of equilibrium to another, if the applied stress is σ, is

$$V(\sigma-\sigma_i)^2/2G.$$

Here G is the shear modulus, and V a volume of order $(200\,\text{A.})^3$. Arguments were given by the present writer for replacing this (for precipitation-hardened materials) by

$$U(\sigma_i) = 0{\cdot}1\,\sigma_i a\lambda^2\left(1-\frac{\sigma}{\sigma_i}\right)^{3/2}.$$

Here a is the interatomic distance, and λ the distance between centres of stress. The chance $\alpha(\sigma_i)$ that a dislocation moves forwards is then, per unit time,

$$\alpha(\sigma_i) = \nu\exp\{-U(\sigma_i)/kT\}.$$

As Orowan[3] in particular emphasized, in transient creep, when the instantaneous extension is at an end, dislocations will be present in the material in positions for which σ_i has all values from σ upwards. Thus creep is, initially, a process of which the rate is determined by activation energies $U(\sigma_i)$ with all values from zero upwards. As the dislocations in particularly favourable positions, that is, those with small $U(\sigma_i)$, are used up, the creep-rate slows down. If $N(\sigma_i)\,d\sigma_i$ ($\sigma_i \geqslant \sigma$) is the number of dislocations, at the end of the instantaneous extension, in positions for which σ_i lies in the range $d\sigma_i$, then after time t the number is $N(\sigma_i)\exp\{-\alpha(\sigma_i)t\}d\sigma_i$. The creep-rate is thus proportional to

$$\int_\sigma^\infty N(\sigma_i)\,\alpha\exp(-\alpha t)d\sigma_i.$$

On the assumption that $N(\sigma_i)$ is constant, this integral has been worked out by the present writer. One obtains an extension-time curve of the type

$$S = \text{const}\,\{\log(\nu t)\}^{2/3},$$

where $\nu \sim 10^9$ sec.$^{-1}$. Such a curve seems to represent transient creep at low temperatures (for example, for lead, Andrade, *loc. cit.*), but certainly does not cover the whole range of phenomena described as transient creep.

An interesting extension of the dislocation theory was given by Cottrell. Cottrell showed that impurities in solid solution would be present in abnormally low or high concentrations in the neighbourhood of a dislocation; he spoke of a "Debye–Hückel atmosphere" of dissolved atoms around a dislocation. This atmosphere, if it is given time to form, will anchor a dislocation in position, introducing a definite local value of σ_i and hence accounting for the existence of a sharp yield point. The explanation was particularly apposite in the case of iron, where the yield point may be taken to depend on the segregation of the easily mobile carbon atoms around the dislocations. Snoek demonstrated to the Conference that the purest iron (less than 0·0001 per cent of carbon by weight) does not have a yield point. It may also be of importance in explaining the considerable observed dependence of yield point on temperature for most metals, on which Druyvesteyn reported to the Conference. It is inherent in the theory of transient creep sketched above that the activation energy $U(\sigma_i)$ is very large in comparison with kT unless σ is within a few per cent of σ_i; therefore, the dependence of yield stress on temperature cannot exceed a few per cent unless the internal stress σ_i is itself temperature-dependent. Cottrell's assumption of an atmosphere of dissolved atoms in equilibrium around the dislocation will obviously lead to a decreasing resistance to yield as the temperature rises and the atmosphere is driven away. The theory also gives an elegant explanation of the phenomenon of micro-creep observed by Chalmers[7] in tin, where the creep-rate for small stresses is proportional to stress; in this process dislocations move, carrying their atmosphere of impurity atoms with them.

Internal Friction

Snoek[8] reported on his work on the elastic after-effect in iron; he showed that damping of vibrations in iron is partly due to the dissolved carbon atoms which set up local stresses, and which, in jumping from one equilibrium position to another, absorb energy from the vibrations. Other work on internal friction, this time on gold-copper alloys, was reported on by Guillet, who pointed out the very low damping of the alloy Cu-Au after quenching; in this quenched alloy, presumably very small tetragonal domains are found.

One can now distinguish the following mechanisms which account for internal friction: (*a*) thermal currents between crystals of a polycrystalline material, or between strained regions of one crystal[9]; (*b*) slip along crystal boundaries, producing elastic strains in the adjoining material[4]; (*c*) presence of mobile dissolved atoms producing a tetragonal strain (for example, carbon in iron, as described above); (*d*) presence of mobile dislocations; internal friction of this kind is much reduced by annealing (recovery), and increased by quite small amounts of cold work[10].

The cause of absorption of energy from vibrations of small amplitude is not the motion of a dislocation from one position of equilibrium to another, but its vibrations about one position of equilibrium. The amplitude of vibration (and hence the damping) should for low frequencies be proportional to $\lambda^2(\sigma/\sigma_i)^2$, where λ is the distance between the centres of strain. Thus increasing hardness (increasing σ_i) gives low damping, as does also small values of λ. The small distance between the stressed tetragonal domains in the quenched Cu-Au alloy is likely to be the cause of the abnormally low damping.

W. G. Burgers[11] discussed recovery and recrystallization, and emphasized the difference between them. Recovery seems to be connected with the motion of dislocations, which move under each other's attraction or repulsion. In recovery, individual crystals retain their identity, and lose only part of their work hardening. In recrystallization, on the other hand, new crystals, having fully the properties of the annealed material, are formed and eat up the cold-worked material by a process at present little understood, but not so obviously connected with the motion of dislocations.

Diffusion and Precipitation

Meijering discussed the oxidation of silver containing aluminium in solid solution. Oxygen dissolves readily in silver, but the binding energy is small. The binding energy of aluminium and oxygen is large, and oxygen atoms diffusing in from the surface are trapped when they encounter aluminium atoms. A sharp boundary is formed between the interior of the specimen, which contains aluminium atoms in solid solution, and the exterior, which contains single molecules of aluminium oxide. These molecules are too large to diffuse through the lattice, and their binding energies are so high that they are unable to dissociate and diffuse as single atoms. Oxidation hardens the alloy, and the normal effects of over-ageing, leading to softening and the formation of microscopic particles of precipitate, are suppressed.

An X-ray analysis of more usual types of precipitation was reported by Guinier. His results, parts of which have already been published[12], are obtained by the use of a single-crystal specimen and monochromatic radiation. In aluminium-copper alloys, where the solute atoms differ in size from those of the solute, the initial nuclei of precipitation are plates one or two atoms thick and about 25 A. in diameter. From absolute intensity measurements he finds that about a fifth of all the copper atoms form such plates, the remainder staying in solid solution. The initial nuclei are about 90 A. apart. In the aluminium-silver alloys, where all atoms are of nearly the same size, the initial nuclei are roughly spherical, and may be considered as sinusoidal fluctuations in the concentration of silver atoms with a wave-length of about 70 A.

N. F. Mott

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THEORY AND PRACTICE OF DYEING

THE symposium held by the Society of Dyers and Colourists at Blackpool during September 25–27, to discuss recent advances in textile coloration, may prove to be of great importance, not only in the annals of the Society itself, but also in the modern history of the subject. The interests of the Society have always ranged very widely, including, at one end of the scale, the industrial production of tinctorial materials and processed fabrics, and, at the other, fundamental studies of textile fibre properties and the chemical and physical processes underlying the operations of dyeing, printing, finishing, etc. Increasingly in recent times, due principally to the growth in the physical sciences, and the narrowing specialization thereby encouraged, it has become difficult for workers situated at these antipodes to know about and to appreciate the significance of each other's work. This symposium marked a *rapprochement* perhaps more significant and more far-reaching than could properly be conveyed by the most careful and accurate summary of the material in the papers read and in the discussions which ensued.

The programme was almost as variegated as the interests of the members. A group of papers contributed by Dr. T. Vickerstaff and his colleagues of Imperial Chemical Industries, Ltd., by Mr. J. Crank of Courtaulds, Ltd., and by Dr. S. M. Neale and Mr. J. M. Preston of the Manchester College of Technology, attempted to define quantitatively the intimate mechanisms of dyeing processes in terms of the energy changes occurring during the processes, or by reference to the active chemical groupings and fine structure of the fibres. What may be called without disparagement the empirical technical side included an informative and well-arranged review of American and German dyeing methods by Dr. R. G. Fargher of the Shirley Institute, a discussion of automatic temperature control in dyeing machines, analytical methods for the identification and assaying of dyes, technical advances in the dyeing of acetate rayons, etc. The latter, the technical, group of papers had, of course, the wider appeal and the more general intelligibility, and they were discussed at length from all parts of the meeting. The first group, however, might fairly be said to have shown itself to be of the greater significance for future development and to have presented the most interesting, and, in the discussions that followed, the most amusing impression to the general observer.

The papers in this group were couched largely in the language and symbolism of physical chemistry, and, in spite of very ingenious interpretative efforts on the part of the protagonists, especially Dr. Neale, their direct and ultimately weighty influence on industrial procedure could not be fully appreciated by many of those whose daily concern is the bulk-production of finished textiles for a competitive market. This situation did not, as it might have done, result in a wider cleavage, but led rather to attempts to define the function of the technologist as the agent for bringing about a liaison between the two sides, and a call for the increased intake of young trained scientific workers into the textile industries. This point of view was put very forcefully and cogently in the discussions by Mr. R. J. Hannay, himself a chemist and calico printer of wide experience and consistently progressive attitude. What may be regarded in some degree as an admonition to both sides came from Dr. E. B. Abbot of I.C.I., who reviewed many of the recent advances in our knowledge of dyeing mechanisms, and attempted to show the extent to which this knowledge has been, or could be, made applicable in the conduct of full-scale processing operations. One most important statement is best given in Dr. Abbot's own words. "A criticism frequently levelled at research workers by technologists is that they are too far removed from realities. In the case of the direct dyes on cellulose, however, we feel that much of the research work has, on the contrary, been too closely related to narrow practical aims, and has consequently lacked that breadth of speculative perception by which primary truths are revealed. We believe the type of research carried out by Neale and his co-workers on direct dyes and cellulose to be more correctly motivated, but an extension of this work, particularly towards a wider examination of different dyes, is required." For this report to do justice, it must be said that, in the discussion, a very strong attempt was made to justify what may be called the interim type of investigation, in which technical behaviour of a range of dyes is defined quantitatively and working rules are enunciated without immediate reference to ultimate causes. In long-established industrial processes such as dyeing, where superficially simple operations exploit a very complicated interplay of variables, these interim investigations often represent the only practicable first assault on the technical problems that need to be solved. There is a danger in this type of investigation that the volume of data which may accumulate from the use of comparatively simple experimental methods may obscure the limits of its value and may lead to premature complacency.

An attempt may now be made to deal in greater detail with the contents of the more fundamental papers. Following the general line of progress in dyeing theory, it may be said that these papers again emphasized the greater ease and certainty of the theoretical treatment of the dyeing process for basic fibres as compared with cellulose. The papers, and the discussions that followed, showed clearly that the authors had reasonably adequate physico-chemical machinery at their disposal for testing and developing their theories, once they had decided on the theoretical mechanism to be tested; but it was soon obvious that the initial picture of the same or similar mechanisms differed markedly from author to author. This situation was to be expected in view of the great complexity of the total phenomenon under discussion, and it applied with particular force, as hinted above, to studies with the cellulose fibres. This situation lent support to the repeated contention by Dr. Neale that experimental attack must be pressed from as many different experimental angles as might be imaginatively possible. His own contribution consisted in a treatment of electrical field characteristics, due to ionic charges on the dyestuff particles and on the fibre surrounded by the aqueous dye solution, which control the approach of the dye particle to the fibre and modify the rate and magnitude of absorption which is ultimately effected by short-range forces. The experimental data were provided largely by the study of surface potentials at the fibre solution interface, and emphasized particularly the technically important influence of the presence of other small mobile ions such as sodium, chloride, etc.

The general picture of substantive dyeing processes with dyestuffs that are ionized in solution now appears to be fairly clear. The total process can be divided into three main steps: (*a*) a diffusion mechanism by which dissolved dye particles enter and leave an indifferent, porous, solid fibre, the equilibrium distribution of dye being imposed by purely mechanical conditions such as size, shape and velocity of the particles, and size and irregularity of the pores; (*b*) modifying this, an affinity factor, in which short-range chemical forces between dye- and fibre-substance encourage the retention of the dye; and (*c*) the creation of electrical double-layer effects due principally to the natural surface charge of the fibre and the immobilization thereon of dyestuff and other ions. The consideration of the last factor has been developed effectively by Neale and other workers to explain and evaluate the important technical effects of accompanying electrolytes in the dye-bath, since it has been shown, for example, that the Donnan membrane equilibrium principle can be used to account for ionic concentration differences within and without the fibre. Mr. J. Crank, of Courtaulds, drawing largely on the experimental data of Neale, further developed the study of the last factor. The original negative surface charge of the cellulose, augmented by the charges of adsorbed dye anions, is imagined to present a 'potential barrier' to the entry of further dye ions, a barrier which is penetrable only by ions which have a kinetic (activation) energy great enough to enable them to overcome the electrostatic repulsion. The free diffusion process is therefore modified by the fact that only a fraction, defined largely by the temperature, of the total external dye is available to penetrate a repulsive field the stopping power of which will be defined largely by the concentration of free and adsorbed dye and other ions. A method of calculating the magnitude of 'true' diffusion of the dye in cellulose (see *a* above) uninfluenced by chemical and electrostatic forces was worked out. Although the development of this method was necessarily incomplete, there is a promise that it may be possible to separate mechanical factors such as fibre orientation and dye particle-size from chemical factors in considering the dyeing of a specific dye on a specific fibre.

The chemical affinity factor was considered in detail by Dr. R. H. Peters of I.C.I. This work was based on the assumption by a number of previous workers that the attachment of dye to fibre is effected when, with favourable molecular dimensions in dye and fibre, hydrogen bonding can take place between specified active groups in the dye and hydroxyl groups in the cellulose. Following the adaptation by Vickerstaff and Peters of the Gilbert–Rideal equation, the standard free-energy change of the adsorption process was defined as the affinity of the dye. This value was calculated from adsorption isotherm data for the dyeing of a number of different forms of fibrous cellulose with a number of direct cotton dyes, with varying conditions of temperature and accompanying salt concentration. It was shown that the affinity so calculated is practically independent of the internal structure of the fibre for any one dye. The values of affinity as between one dye and another, dyes which, incidentally, deviate from each other very markedly in their exhaustion characteristics, are not of a very different order. The important deduction was therefore possible that the mode of attachment of dye to fibre is similar for all the dyes examined on all the fibres, the great individual differences observed in the dyeing behaviour of direct dyes being attributable to differences in the fine structure of the fibre and the state of aggregation of the dye particles.

A very similar picture was presented by Dr. Vickerstaff and Mr. D. R. Lemin as the result of an analogous treatment of the absorption of monobasic acid dyes by wool. The transfer of dye ions between solution and fibre was accomplished experimentally in different ways and calculations were made of the affinity. This was defined as the difference between the thermodynamic potential of the dye anion at unit activity in the solution and that of the same ion at unit activity in the fibre. The affinity of a particular dye calculated from the results of three different methods of determination, namely, direct adsorption, displacement of the dye from the dyed state by other anions, and competition of the dye with another for the fibre, led to reasonably consistent values. Here again, the affinity values were of a similar order of magnitude for all the dyes examined, so that a means seems to have been found for expressing quantitatively the strength of chemical attachment between dye and fibre, independent of many of the accidental properties of fibre and dye solution.

It is not the intention of this report, in thus singling out these two or three papers for special consideration, to diminish the value of the many other excellent ones that were discussed at the meeting. This group, however, with one other of a different kind, that of Dr. H. J. Selling of Delft, does appear to be of the greatest significance for the future, and the forward-looking spirit of the gathering was consistently maintained. Dr. Selling has made a heroic attack on a very difficult problem that has always attracted the interest of scientific workers in the dyeing industry. This is the specification of shades and the control of the dyeing process by means of the colorimeter, a process which, up to the present, has required almost complete reliance upon direct visual judgment. It was shown that patterns dyed with comparatively simple mixtures of dyes can be analysed colorimetrically with sufficient accuracy to allow matching dyeings to be produced solely on the data thereby furnished. Technically, this is a very considerable achievement, and although the method is not yet ready for general introduction into the dye-house, the beginning thus made is extremely promising. If instrumental patterning becomes possible, the next step may be automatic control of the course of the dyeing operation, and the dyer's Utopia will be in sight.

Apart from the very pleasant social atmosphere which marked the whole of the symposium, encouraged by the excellence of its management and the character of the discussions, one further item must be mentioned as contributing very markedly to the general success. This was the readiness of some of the larger firms concerned with the textile industry to allow their research staffs to make serious and extensive contributions from the results of work carried out in their laboratories. This attitude, so important for general progress, has not always been so much in evidence, nor is it yet universal. The chief guest at the Society's dinner was Mr. A. H. Wilson, recently University lecturer in mathematics at Cambridge, who, after a distinguished career in the field of pure science, now holds an important administrative position in the industry as director of research and development of Messrs. Courtaulds, Ltd.; his considered compliments on the scientific activities of the Society of Dyers and Colourists will be a source of great encouragement. H. A. TURNER

HOW FAR CAN BRITAIN FEED HERSELF?

THE Nutrition Society, at a whole-day conference held on October 25 at the London School of Hygiene, discussed "British Needs and Resources of Calories, Protein and Calcium". The Right Hon. Walter Elliott was in the chair.

The conference was planned some months ago, before the food situation became so threatening. In the first place, nutritionists were asked to give their considered opinion as to what amounts of food were needed in the United Kingdom to meet adequately the whole physiological needs of the human population, having regard to the dietetic habits of the British when unhampered by rationing. In the second place, a number of agricultural and fishery authorities, having been given a preview of the nutritionists' requirements, were invited to say how far British food resources could reasonably be developed to meet these requirements. The present alarming situation, when even minimal nutritional needs, despite the utmost austerity of rationing, are far from secure, was unforeseen when the conference was planned, but lent a sombre interest to the proceedings. One of the speakers remarked that though it was not on the agenda of the conference, an important and urgent question for discussion in the near future should be what we could do, having the new stringencies in mind, to meet from the agricultural and nutritional points of view a situation in which home production of food plus what Britain could buy with her failing credit from overseas threatened to be not merely below reasonable physiological needs, but even below minimal nutritional requirements for health and work.

In the first paper, Dr. E. R. Bransby, Dr. H. E. Magee, Mrs. M. C. Bowley and Miss B. R. Stanton gave a careful estimate, on the basis of the needs of the various age-groups in the population, of the amounts of different foods required to meet the requirements for calories, proteins and calcium of the whole population of the United Kingdom, both at the 1946 population of 48 million, and at the estimated 1964 population of 50 million (which would have a different age-group composition). They calculated these requirements on the amounts of food needed to enter the retail stage of distribution, not those actually eaten. The calories entering the retail stage are, in fact, some 10–15 per cent higher than those actually consumed, as determined by careful nutritional surveys—a gap for which, as yet, there is no adequate explanation.

The changes between the requirements as stated by Bransby *et al.* and actual pre-war supplies entail an increase of 48 per cent in milk and dairy products, of 56 per cent in potatoes and of 27 per cent in vegetables. Sugar needs are, however, below the pre-war level by 14 per cent, and the needs for fruit, fats, grain, meat, pork and eggs about the same as the pre-war level. It was stated that the diets as given provide not only all the physiological requirements for calories, proteins and calcium, but also those for all the other known nutrients. As regards protein, though for most age-groups more than half the total requirements were provided by animal protein, the authors thought that no clear evidence exists as yet as to what is the optimal amount of animal protein needed for a human dietary at different ages.

The discussion on the estimates given by Bransby *et al.* was opened by Mr. F. le Gros Clark. He doubted whether the menus which the first speakers had tabulated were really typical for those of the majority of the population of Great Britain. A good deal of our animal protein comes at present, and will continue to come, from milk, and he considered that the milk products/meat ratio should be increased. In estimating future requirements for the different types and qualities of food it is, of course, necessary to assume that the present relative prices will be maintained; but nevertheless, over even a short period of years, changes would undoubtedly take place which would greatly affect the demand for, and the consumption of, many items in the diet. In absence of rationing, and in view of the probable continuance of a high rate of employment and of wages, and of increasing education of the public in nutritional matters, he considered that it is highly probable that the demand for some of the more nutritious and tasty foods would exceed the needs as given in the first paper.

Prof. John Beattie mentioned experimental work on the calorie requirements of German prisoners under sedentary and under physically more strenuous conditions. It was found that, after loss of weight on a meagre diet, an immediate rise in food intake does not permit of increased expenditure of working energy until after a lag period, during which the lost reserves are being built up again. His view was that the adult male age-group should receive an *average* of 3,500 calories, rather than the 3,000 that Bransby *et al.* considered sufficient.

Dr. E. C. Owen pointed out that the basis for the figures usually accepted for calcium requirements is not very secure. Individual requirements vary greatly. For various reasons, old people often get less calcium than they need. As regards the virtues of animal as compared with vegetable protein, he considered that the main factor is lysine, the irreplaceable amino-acid present in reasonable quantities in most animal proteins, but found to a much smaller extent in vegetable protein.

Dr. Isabella Leitch was dubious as to the basis of some of the previous estimates of food requirements. The right method is to draw up adequate menus for the whole population, and calculate total food needs on that basis. She could offer no satisfactory explanation of the gap of 10 per cent or more between 'food entering retail consumption' and that actually consumed in the house. This apparent wastage, however, varies greatly from one food to another. In the case of milk it is small. In estimating calorie requirements for the adult working population, little more than a guided guess is at present possible, since the actual physical work done is so difficult of assessment.

If the gap between the estimate of food production plus imports and actual food consumption were as small as 10 per cent, Prof. J. R. Marrack thought that those making this estimate were to be congratulated. His view was that the average calorie requirement of adult male sedentary workers was usually appraised at too high a figure.

Dr. Wood suggested that three tables of food needs might be prepared: (1) the minimum nutritional requirements for health; (2) the requirements from the popular point of view, where items like sugar would be high; (3) the requirements if food were given away free.

In replying to these comments, Dr. Bransby stated that the diets suggested by himself and his colleagues were intended to be appreciably above the minima, and, in fact, at the 'comfort' level.

The first paper to approach the question as to how far the nutritionists' requirements could be met from home production was given by Dr. E. T. Jones, who dealt with wheat, potatoes and sugar-beet. He considered that by increased efficiency and more intensive management, yields per acre of wheat and sugar-beet could be fairly rapidly increased to provide from home sources fully 50 per cent of the total needs of Britain for bread grains and sugar. Such an increase would depend on the liberation of more than 680,000 acres from potato production. This could be achieved, and our potato crop still meet national requirements, if cultural technique were improved, by the application of existing knowledge, to give an average yield of 10 tons of potatoes per acre.

In the second paper, dealing with home production of milk and dairy products, Prof. H. D. Kay stated that to satisfy the nutritional requirements of Britain for liquid milk alone would entail an increase of about 25 per cent above our present annual total of some 1,360 million gallons of milk leaving the farm. He considered that, without any increase either in numbers or quality of our existing dairy cattle, a 10 per cent increase in milk coming off farms could be achieved if 400,000 tons of concentrated feeding stuffs, in addition to the quantity grown or imported at present, could be provided. This represents only 6 per cent of our pre-war total import of concentrates. The remaining increase of about another 15 per cent in the milk coming off farms could be attained by improving the genetic quality of the dairy cows—but without any increase in their present numbers—by artificial insemination from bulls of the quality now in use in cattle-breeding centres. At present rates of progress in the development of artificial insemination, this would take some ten years. Additional feeding-stuffs would, of course, be needed *pari passu* with the increase in potential milk-yields of the improved stock. He also emphasized that the technical skill both of the dairy farmer and his cowman would have to increase at the same time as his stock was improved, if full use was to be made of the effect of artificial insemination from high-class bulls.

Dr. J. Hammond discussed the difficult question of increasing the home production of meat (beef, mutton and pig meat) despite the simultaneous demands for home-produced and imported feeding-stuffs which increased milk production and egg and poultry production would make. The total needs of meat, according to the nutritionists' requirements, are some 146 lb. per person per annum, of which only 38 lb. is at present produced in Great Britain. More beef might be produced at home by using good beef bulls, kept at artificial insemination centres, on the poorer milk-producing cows, to give colour-marked progeny that would not be mistaken for dairy animals. More winter feed for both beef cattle and sheep would be needed if meat production were to increase. As regards pig meat, any large increase would depend almost entirely on a rise in the supply of feeding-grain from abroad, though something could be done if more farms kept a few extra pigs which might act as scavengers and need relatively little food from outside the farm.

The possibility of increased fish supplies was considered by Mr. R. J. H. Beverton and Mr. G. C. Trout. The danger of over-fishing the North Sea was pointed out. It is considered that increased supplies of cod and other fish could be obtained from more distant fishing grounds, but this might entail the use of factory ships, since storage difficulties on the ocean-going trawlers are very great. As regards herring, there is no evidence whatever of an approach to the stage of depletion of reserves—many more could undoubtedly be caught fairly close to the British Isles. Here the difficulty is to dispose of the catches obtained in the peak period, by suitable methods of preservation. Increase of supplies of fish other than the herring undoubtedly lies in the exploitation of the more distant fishing grounds, and a 40 per cent increase in supplies is a possible attainment in a few years.

Egg production was discussed by Mr. E. T. Halnan. If larger quantities of suitable feeding-stuffs could be provided, he foresaw little difficulty in producing the increase of some 6,000 million eggs called for by the nutritionists. But with the greatest possible production of wheat and barley at home, and with a change in the rate of extraction of flour from the present 85 per cent down to the pre-war 70 per cent—neither of which seems likely—at least 368,000 tons of imported feeding-stuffs would be needed. From the figures he gave for present egg production, it appears that an unduly large number of eggs, apart from those legitimately produced by the 'backyard poultry keeper', are evading the official rationed channel at present.

The general discussion was opened by Dr. W. K. Slater. He emphasized that the additional production of food from sources in Great Britain means increased supplies of materials, for example, for additional factories and plant for extracting sugar-beet and for housing poultry. The training of the human element in more efficient methods of cultivation and of management of stock is likely to be a formidable task. He asked whether a true appreciation of the immediate future position in Great Britain is rather that the number of calories per person and the nutritional value of the average diet generally are much more likely to fall than to rise; and how far this fall could go without acute sequelæ.

Dr. N. C. Wright considered that a matter of immediate importance is the prevention of wastage, from whatever cause, of food already produced. We must find out, for example, exactly what happens to the 10–15 per cent of calories that vanish as between food 'moving into consumption' and food actually consumed in the household. He believed there is no escape from a greatly increased importation of animal feeding-stuffs from overseas if home-produced human food is to increase.

The importance of disease control and the part that the veterinary profession could play in preventing wastage were emphasized by Dr. W. R. Wooldridge. Prof. J. R. Marrack inquired whether, if the amount of milk required per head per day by the nutritionists has to be produced as liquid milk during the *winter* months, it would not thereby entail a considerable excess to liquid requirements at the production peak during spring and summer, which excess could provide a substantial quantity of dairy products.

Prof. A. W. Ashby, in summing up, said that we should face the fact that the standards in Great Britain for human food have been reduced to, and are likely to remain for some time, those of a rather poor peasant population. He considered that more co-ordinated consultation between the experts in nutrition and in food production and the administrative authorities is needed to give a sound basis both for the planning of increased food production at home and the carrying of these plans into effect. He criticized some of the figures given by those who had spoken during the conference on the possibilities of increased agricultural production, and thought that more statistical wisdom and mutual consultation might have made their estimates more helpful. He was very doubtful whether the yields per acre of wheat, etc., that one of the speakers had assumed as attainable in the near future, could, in fact, be reached. Competing requirements for feeding-stuffs to provide milk, meat and eggs have to be regarded from the point of view of efficiency of conversion of feeding-stuffs to human foods. Here the dairy cow is far superior to the bullock. He emphasized that under an effective system of price control the *relative* prices offered to the producer for the different farm products is the main directive factor in influencing relative volumes of farm output.

The chairman, in conclusion, mentioned the surprisingly large total tonnage, relative to the tonnage of human food, that is needed to feed the animal population of Great Britain, and emphasized the importance and economy of producing the maximum quantity of feeding-stuffs at home by the intensive application of existing knowledge.

The proceedings of the conference will be published in an early number of the *British Journal of Nutrition.*

OBITUARIES

Prof. J. Masson Gulland, F.R.S.

It was with a sense of severe personal loss that his many friends learned of the untimely death of Prof. J. M. Gulland, who was a victim of the railway accident at Goswick on October 26. He was a leading figure in the chemical world, a pioneer worker in several important fields of organic chemistry and biochemistry, and a man of outstanding personal charm.

John Masson Gulland was born in Edinburgh in 1898 and was the only son of the late Prof. G. Lovell Gulland, professor of medicine in the University of Edinburgh. Gulland was much devoted to his native land, and above all to his native city, which he frequently visited. He was educated at Edinburgh Academy and the University of Edinburgh, where he graduated in 1921, after serving as a second lieutenant in the First World War. At that period it was natural for a graduate of a Scottish university with an interest in organic chemistry to turn his eyes towards St. Andrews, and, having been awarded a Carnegie Scholarship, Gulland went there to work under Prof. (later Sir) Robert Robinson, whom he rejoined in Manchester and again later in Oxford. Gulland became a University demonstrator in chemistry at Oxford in 1924, and was appointed lecturer in chemistry at Balliol College in 1926. These appointments he relinquished in 1931, when he became senior assistant in biochemistry at the Lister Institute, London, and a reader in biochemistry in the University of London. In 1936 Gulland was appointed to the Sir Jesse Boot Chair of Chemistry at University College, Nottingham, which post he resigned in September of this year in order to take up a new appointment as director of research to the Institute of Brewing. This position had been vacant since the death of Sir Gilbert Morgan in 1940, and in reviving the post the Institute of Brewing planned to expand its research activities and to set up its own central research laboratories. At the time of his death, Gulland had already begun to apply himself with his customary vigour and enthusiasm to the execution of these plans. He was married in 1924, and is survived by his wife and two daughters.

Although he has a large amount of first-rate scientific achievement to his credit, Gulland was not quite so prolific a contributor to the original literature as some of his contemporaries. This is partly due to the formidable nature of the problems which he tackled; he never engaged in trivialities. It is probably due also to the fact that his earlier ardour for work at the bench tended to be subordinated later to his interest in organisation and administration, for which he had a real flair. He served on the councils of the Chemical Society and the Royal Institute of Chemistry, and was an honorary secretary of the Chemical Society during 1933–36. From 1932 until 1934 he was secretary of Section B of the British Association, and during 1935–37 he was recorder to the Section. During the early years of the Second World War he was senior gas adviser to the North Midland Region of the Ministry of Home Security, and during 1943–44 he was assistant director, Chemical Research and Development, Ministry of Supply. In this capacity he was attracted by the potentialities of alginic acid as a chemical raw material, and he took an important part in the establishment of the Scottish Seaweed Research

Association, the new laboratories of which in Musselburgh, Midlothian, were formally opened in September (see *Nature* of November 15, p. 662); Gulland was a member of the Board of Management of this Association, and chairman of its General Purposes and Chemical Advisory Committees. His department at Nottingham was a model of efficient organisation, and was well equipped for the researches which were carried out there under his inspiration and guidance. He had in recent years planned and supervised the erection of excellent extensions to the laboratories, and these are now playing a valuable part in meeting the heavy demands of the post-war period.

Only the barest reference is possible here to Gulland's scientific work, an appreciation of which will doubtless be published elsewhere. During his St. Andrews and Manchester days, he worked on the morphine group of alkaloids, and the constitution which is now generally accepted for morphine was first adumbrated in two classical papers, published in 1923 and 1925, by Gulland and Robinson. With R. D. Haworth, Gulland published a series of papers on the aporphine group of *iso*quinoline alkaloids (1928–29). New methods were devised by which were synthesized, among other compounds, bulbocapnine methyl ether and corytuberine dimethyl ether. Gulland also made other chemical studies of compounds of biological interest, including pellitorine, the pungent principle of *Anacyclus pyrethrum*, and the active constituents of *Taxus baccata* (1930–31). His work then followed a more biochemical trend and he investigated (with R. A. Peters) the reducing substances of pigeon's blood, and carried out a series of investigations on the oxytocic principle of the pituitary gland (1932–35), elucidating something of the chemical nature of this hormone. His major contributions to science are those carried out during the past twelve years on the chemistry of the nucleic acids, and of the nucleotides and nucleosides from which they are built up. Some of this work was summarized by Gulland in his Tilden Lecture given before the Chemical Society in 1943 (*J. Chem. Soc.*, 208; 1944). The pre-eminent part which the nucleoproteins play in the fundamental processes of life has become increasingly apparent in recent years, and gives added significance to Gulland's investigations in this field. It is a great misfortune to biological science that they have been so abruptly terminated.

J. W. COOK

WE regret to announce the following deaths:

Prof. W. S. R. S. Lewis, professor of geography at the University College of the South-West, Exeter, on November 14.

Prof. Frank R. Lillie, emeritus professor of embryology in the University of Chicago, president during 1935–39 of the U.S. National Academy of Sciences.

Mr. W. J. U. Woolcock, C.M.G., C.B.E., a past-president of the Society of Chemical Industry, on November 13, aged sixty-nine.

NEWS and VIEWS

Nobel Prizes for 1947

Sir Robert Robinson, F.R.S.

THE award of the Nobel Prize for Chemistry for 1947 to Sir Robert Robinson, president of the Royal Society, can have occasioned little surprise in view of his outstanding contributions to organic chemistry. They cover so wide a field that it is only possible to refer to a few of the more important of these. His early work on brazilin and hæmatoxylin, carried out in collaboration with the late Prof. W. H. Perkin, led to new pyrylium salt syntheses, which were later extended and applied to the artificial preparation of the anthocyanins, the chief red and blue pigments of flowers and blossoms, thus providing a final proof of the structures assigned to some of them by Willstätter. The possession of the pure synthetic specimens made it possible to devise simple quick tests for the anthocyanins contained in a few petals, which have proved to be of great value in genetic investigations. Of equal brilliance are his investigations in the alkaloid field. His simple synthesis of tropinone was rather the outcome than the cause of a theory of biogenesis of plant products put forward in 1917. This theory collated for the first time the apparently dissimilar alkaloidal constituents, and it has proved useful both in prediction and in criticism. The structures put forward for morphine and thebaine have found general acceptance. Undoubtedly his greatest contribution in this field has been his extended study of the chemistry of strychnine and brucine.

Sir Robert's mastery of the synthetic method and his penetrating insight is revealed in the long series of memoirs on the synthesis of the steroids. His work in this field has led, in collaboration with Prof. E. C. Dodds, to the synthesis of stilbœstrol, a useful and active œstrogen, which has found application in the treatment of certain forms of cancer. During the recent War he was the leader of the Oxford team engaged on the chemistry of penicillin, and it was in his laboratory that the main facts of its constitution were first elucidated. Finally, mention must be made of his contributions to the electronic theory of organic reactions. This theory was based originally on the discovery of C-alkylation of substituted aminocrotonic esters and was later extended by many other observations. Robinson's theoretical views, developed during the decade 1920–30, were subjected to severe criticism, but they have survived in almost unmodified form and they have now found general acceptance. It is not too much to say that the system first advanced by Robinson and his collaborators is the basis of the modern chemistry of organic chemical reactions. Robinson and his school have exercised a profound influence on the development of organic chemistry, not only in Great Britain but throughout the whole Commonwealth. Many of his former students and collaborators hold university professorships or fill important positions in chemical industry.

Sir Edward Appleton, G.B.E., K.C.B., F.R.S.

THE announcement of the award of the Nobel Prize for Physics for 1947 to Sir Edward Appleton is one which will be received with great satisfaction by scientific men everywhere, and particularly by workers in pure and applied physics. Sir Edward

Appleton has achieved renown in two spheres, either of which might be considered as forming a sufficiently full life for a lesser man of science. He has for more than a quarter of a century been the most active worker in the field of radio physics, and during this period he has conducted research work of the most far-reaching importance. Since 1939, also, he has been secretary of the Department of Scientific and Industrial Research, a position which gives him the responsibilities and duties of the leading man of science in the Government service of Britain. Appleton displayed his great scientific ingenuity and experimental skill in December 1924, when he demonstrated the existence of the Heaviside layer as an ionized region of the atmosphere capable of reflecting electromagnetic waves. Shortly afterwards, he discovered another and higher region—the Appleton layer—from which the shorter radio waves are reflected after they have penetrated the lower region. From that time onwards Appleton has conducted a continuous series of researches on the characteristics of the ionosphere, and the part they play in determining the mode of propagation of radio waves round the earth. The techniques developed in the course of these investigations provided the foundations for the development of radar in Great Britain, while the results of the research on the ionosphere have proved invaluable in forecasting and allocating the most suitable frequencies for practical radio communication, broadcasting and other applications. More recently, Sir Edward Appleton, in co-operation with other workers, has devoted attention to the reflexion of radio waves from meteors, and has demonstrated that sunspots are powerful sources of very short radio waves.

His work during the war years as secretary of the Department of Scientific and Industrial Research was particularly onerous for, in addition to conducting the normal activities of the Department, he was called upon in 1941 to advise the Government on the magnitude of the effort to be devoted to the exploitation of nuclear energy, and later to set up a special section of the Department to carry out the necessary research work forming the British contribution to the development of the atom bomb. Sir Edward, who was elected a fellow of the Royal Society in 1927, has received many honours and awards in Great Britain and overseas, and he has been president of the International Scientific Radio Union since 1934.

Royal Society: Medal Awards

His Majesty the King has approved the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows:

Prof. C. N. Hinshelwood, Dr. Lee's professor of chemistry, University of Oxford, for his distinguished work on the mechanism of chemical reactions, from the simplest gas phase processes to the complexities of cell division;

Dr. F. M. Burnet, director of the Walter and Eliza Hall Institute for Medical Research, Melbourne, for his distinguished work on bacteriophages, viruses and immunity; and for his contributions to the study of infectious disease as an ecological phenomenon.

The following awards of medals have been made by the President and Council of the Royal Society:

Copley Medal to Prof. G. H. Hardy, emeritus professor of pure mathematics, University of Cambridge, for his outstanding part in the development of mathematical analysis in Britain during the last thirty years;

Davy Medal to Prof. L. C. Pauling, director of the Gates and Crellin Laboratories, California Institute of Technology, for his distinguished contributions to the theory of valency and for their application to systems of biological importance;

Buchanan Medal to Sir Edward Mellanby, secretary to the Medical Research Council, for his distinguished researches on the physiology of nutrition, especially in relation to the causation of deficiency diseases;

Hughes Medal to Prof. J. F. Joliot, director of the National Centre of Scientific Research, Paris, for his distinguished contributions to nuclear physics, particularly the discovery of artificial radioactivity and of neutron emission in the fission process.

Physiology at St. Thomas's Hospital Medical School: Prof. H. Barcroft

Prof. Henry Barcroft, Dunville professor of physiology, Queen's University, Belfast, has recently been appointed to the University chair of physiology in St. Thomas's Hospital Medical School, London. Prof. Barcroft is a son of the late Sir Joseph Barcroft of Cambridge, and was educated at Marlborough College and King's College, Cambridge. He held the Harold Fry and George Henry Lewis studentships at Cambridge during 1927–29 and was awarded the Gedge Prize in 1930. He qualified in medicine at St. Mary's Hospital, London, after which he was appointed lecturer in physiology at University College, London, a post which he occupied from 1932 until 1935. He has held the chair of physiology at Queen's University, Belfast, from 1935 until the present time, and has carried out distinguished work on the control of the vasomotor system, and of the blood flow to the limbs and other parts of the body. His experiments were mainly carried out on the human subject and involved important observations on the physiology of syncope.

Jubilee of the Discovery of the Electron

The fiftieth anniversary of the discovery of the electron was recently marked in Cambridge by an open meeting of the Philosophical Society at which a lecture on the history of the Cavendish Laboratory was given by Dr. Alex. Wood in that Laboratory. Dr. Wood was himself a research student under Sir J. J. Thomson and has been closely associated with the teaching work of the Cavendish Laboratory since 1905. His lecture was illustrated by exhibits of historical apparatus used by Clerk Maxwell, Rayleigh, Thomson and Rutherford. Among guests present were Dr. G. F. C. Searle, who as a boy was shown round the Laboratory by Clerk Maxwell shortly after it was built; Mr. J. E. Rolph, who was appointed as laboratory assistant by Lord Rayleigh in 1881; Mr. F. J. Lincoln, who was a laboratory assistant for fifty-three years, including forty-two years as steward; Sir William Dampier, who as W. C. D. Whetham joined the Laboratory in the very early days of Sir J. J. Thomson's professorship; and Lady Thomson, who as Miss Paget was a research student in 1889 and was married to J. J. Thomson in 1890.

British Books for Germany

At the Information Centres of the Control Commission in the British Zone of Germany reference books are available for those who live near enough;

and special arrangements are planned for educationists and writers of school and university text-books. British books cannot, however, be purchased by Germans. The Control Commission has officially approved a scheme, put forward by the Agency for Intellectual Relief in Germany, under which the Agency will establish lending libraries for British books in key-centres of the British zone. The first library, containing some four thousand books, is being opened in Hamburg. Once the libraries have been established, German committees in each town will take over the management; it is expected that current expenditure in Germany will be covered by the borrowers' fees. A list of books needed, based on suggestions by German readers, has been prepared. Contributions are solicited towards the cost of books that must be bought; cheques should be sent to the honorary treasurer of the Agency for Intellectual Relief in Germany, C. P. Kininmonth, 4 Chapel Row, Wheeler End, High Wycombe, Bucks. Information relating to the scheme can be obtained from the Agency for Intellectual Relief in Germany, Foreign Office, German Section, 48 Prince's Gardens, London, S.W.7.

Import of Scientific and Technical Books

REPLYING to a question in the House of Commons, the President of the Board of Trade stated that he is prepared to consider the issue of licences for limited additional imports of technical and scientific books in English from certain European countries. Similar books in foreign languages from non-English speaking countries are licensed freely.

German Hydrographic Institute, Hamburg

THE first annual report of the German Hydrographic Institute, Hamburg, consists of a 64-page booklet both in German and English (the former language being that of the official text). It gives a good account of the provision which has been made in Germany since the War for the performance of the various tasks formerly undertaken by the organisation which was the German analogue of the Hydrographic Department of the British Admiralty. Along with that account, which tells of work to do with marine surveying, the making and printing of nautical charts, the issue of nautical books, the testing of compasses, the observation and publication of magnetic values, the issue of time signals, and with many other matters concerning which information is needed by mariners and required by the naval side of the Allied occupying authority, there is substantial information bearing upon the present state of German oceanography.

Before the War, the science of oceanography had numerous practitioners in Germany, and, in addition to the two well-known and very large organisations devoted to its furtherance, there were several small scientific bodies of repute which worked in this sphere. The report records how plans were laid for the employment of about one-fifth of the large number of oceanographers to work upon tasks which should serve the interests of, and meet the needs of, that rump organisation which—it was approved by the Allied Control Council—had to be set up to carry out essential hydrographical duties in German waters. These scientific workers ultimately became Section 2 of the Institute which is the subject of the report. This, established initially by the British naval authorities, is now under the governance of a quadripartite board of four directors, functions in Hamburg, and is 'managed' by the British director, who is a captain in the Royal Navy. Considerable information is given concerning reports which have been written by various German marine scientific workers since the capitulation, and it is expected soon to start upon the issue of a periodical wherein such reports will be printed for circulation.

National Foundry College

THE National Foundry College has been established and its board of governors nominated by the Minister of Education. The College will be housed in, and work closely in conjunction with, the Wolverhampton and Staffordshire Technical College. The board of governors is charged with the responsibility for providing national facilities for foundry education and research, in the form of full-time courses, vacation courses, refresher courses, and the like, and also for providing regional and local facilities for full-time, part-time day and evening courses, to cover the whole range of foundry education. Its first task will be the re-establishment of the full-time diploma course which was the main feature of the predecessor of the College, the British Foundry School, during 1935–39. This course will normally run for an academic year, and the first session opens on January 5. The course will cover the whole of the foundry industry, ferrous and non-ferrous, including grey, white and chilled iron castings, malleable castings, steel castings, and castings in non-ferrous metals, such as alloys of copper, tin, zinc, nickel, aluminium and magnesium. The diploma awarded to successful students will be endorsed by the Ministry of Education. There is no upper age limit for admission; a minimum of one year's practical experience in at least one branch of the industry will be required, together with a Higher National Certificate or a university degree, preferably in metallurgy or engineering, or a grade of membership obtained by examination of a professional institution in engineering, metallurgy or chemistry. Mr. J. Bamford, who was in charge of the British Foundry School during 1935–39, and who has since held important managerial appointments in the industry, has been appointed head of the National Foundry College.

Abstracts on Powder Metallurgy

HITHERTO available in private circulation only, *Metal Powder Report* is now issued at an annual subscription of £3 7*s*. 6*d*. The report is a sixteen-page monthly abstract journal dealing solely with the production, treatment and use of metal powders, under the joint editorship of W. D. Jones and R. A. Hetzig. The use of such products in electronics, the metallization of glass and ceramic materials, iron driving bands, porous aluminium-base bearings, electrical contacts, magnetic materials, sintered plates for batteries, sparking plugs, and stainless steel powders for paints and lacquers, all of which are mentioned in the issues for September and October 1947, will give an indication of the surprising breadth of interest of this very new branch of metallurgy. All concerned with powder metallurgy in any of its aspects will find this publication of real use. It is available from Powder Metallurgy, Ltd., Commonwealth House, 1–19 New Oxford Street, London, W.C.1.

Biological Abstracts

A NEW section of *Biological Abstracts* (University of Pennsylvania, Philadelphia) will be published as from January 1948. The section (*J*—Abstracts of

Cereals and Cereal Products) will appear monthly except during the four summer months, when it will be bi-monthly. It will bring together abstracts of the entire technological and scientific literature on the cereal grains—wheat, corn, rye, oats and barley—and on all other grains such as soya bean, cottonseed, buckwheat, etc., utilized by the milling and food industries. It will include contributions on plant breeding, cultural practices, varieties, soil and weather relations of the crops; physiology, diseases, insect pests; storage of grain and flour; milling machinery and techniques; plant sanitation; baking and nutritional studies on diets in which cereal and related products are important components; biochemistry of cereals and cereal products; enzymes; and industrial microbiology in so far as it affects the cereals and their products.

U.N.E.S.C.O. Fellowships

THE first two of the fellowships placed at the disposal of U.N.E.S.C.O. by the American Chemical Society have been awarded to men of science from Czechoslovakia. The successful candidates are Dr. Milos Hudlicky, assistant at the Institute of Organic Chemistry at Prague, and Dr. Ivan Vavruch, assistant at the Research Institute of the Czechoslovak Sugar Institute, also in Prague. It is hoped that both the new fellows will be able to take up their appointments early in 1948. One of the fellowships offered by the Belgian Ministry of Education under the same U.N.E.S.C.O. scheme has been awarded to Mr. Charalambos Vacalopoulos, who is studying international relations in Brussels. The organisation of a programme of fellowships of this kind is one of the most important of the aims of U.N.E.S.C.O., as it is designed to make it possible for scientific workers, teachers and others from war-devastated countries who were cut off from the outside world during the War to be made acquainted with the most recent developments in the field of their specialization.

Conference on Ethics and Science

IN July last year the British Social Hygiene Council held a conference on "The Problems of Communal Life: the Ethical and Scientific Approach", which proved so successful that the Council was asked to arrange something similar this year. In response to this request, a one-day conference has been arranged for December 4, and will take place in the Livingstone Hall, Tothill Street, Westminster, S.W.1. Its main theme will be "Society and the Individual", which will be considered under two headings, namely, "The Values Society sets upon the Individual", and "The Values the Individual sets before Himself". Ample time will be allowed for discussion at the end of both the morning and afternoon sessions and at an open meeting in the evening. Once again the aim of the Conference is to effect, in some measure, a synthesis between the spiritual and the scientific interpretations of life. The chair will be taken by Prof. Winifred Cullis and Dr. E. B. Strauss, and the speakers include Mr. L. J. F. Brimble, Father Leycester King, Canon Marcus Knight, Dr. E. H. Larkin, Mr. J. Mackay-Mure, Dr. Mary Smith, Mrs. Joan B. Thompson, Mr. Kenneth Walker, and Mr. R. Weatherall. Further information and tickets (members of the Council 2*s*. 6*d*., others 3*s*. 6*d*.) can be obtained from the British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

Royal Society of Edinburgh: Officers for 1947–48

AT a statutory meeting of the Royal Society of Edinburgh, held on October 27, the following officers and members of council were elected: *President*, Sir William Wright Smith; *Vice-Presidents*, Lord Cooper, Prof. J. W. Heslop Harrison, Prof. W. M. H. Greaves, Lieut.-Colonel W. F. Harvey, Prof. James P. Kendall, Sir Ernest Wedderburn; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. Arthur Holmes, Prof. E. T. Copson; *Treasurer*, A. W. Young; *Curator of Library and Museum*, Dr. John E. Mackenzie; *Ordinary Members of Council*, Prof. E. P. Cathcart, Prof. A. Gray, Dr. J. R. Greig, Dr. W. A. Harwood, Prof. C. M. Yonge, Prof. A. D. Hobson, Dr. W. O. Kermack, Dr. John Weir, Prof. J. H. Gaddum, Prof. G. D. Preston, Prof. S. J. Watson, R. Ll. Gwilt.

Announcements

THE Hanbury Gold Medal for 1947 of the Pharmaceutical Society of Great Britain was presented on November 13 to Dr. Hans Flück, professor of pharmacognosy in the Faculty of Pharmacy of the Federal Technical Institute, Zurich.

THE Pedler Lecture of the Chemical Society will be given by Sir Ian Heilbron, professor of organic chemistry, Imperial College of Science and Technology, London, at the Society's rooms on December 4 at 7.30 p.m. He will speak on "Recent Developments in the Vitamin A Field".

DR. W. J. KEARTON, senior lecturer in mechanical engineering in the University of Liverpool, has been appointed to the Harrison chair of mechanical engineering in the University.

MR. JOHN WILSON, director of research to the British Rubber Producers' Research Association, has been appointed director of research to the British Rayon Research Association.

SIR CHARLES ELLIS, president and chairman of Council of the British Coal Utilization Research Association, has announced the following new titles in respect of the directorate of the Association: Dr. D. T. A. Townend, director-general; Dr. D. H. Bangham, director of research laboratories; Dr. E. G. Ritchie, director of engineering laboratories; Mr. J. S. Hales, director of domestic appliance laboratories; Mr. H. T. Hathaway, secretary and finance officer.

THE film "Nagana", introduced by Dr. P. J. du Toit at a meeting held at the London School of Hygiene and Tropical Medicine to discuss "D.D.T. and the Aeroplane in the Control of the Tsetse Fly and Trypanosomiasis in South Africa" (see *Nature*, October 11, p. 485), is now at the South African Scientific Liaison Office, 39 Prince's Gate, London, S.W.7, and is available on loan to scientific bodies wishing to show it. It is a 16-mm. colour film with sound-track.

THE Boron Agricultural Bureau announces that its work will be brought to a close at the end of December 1947. Its comprehensive collection of literature on the uses and functions of boron in agriculture, which has been assembled during the last eleven years, will be presented to the library of the Rothamsted Experimental Station, where it will be available for consultation.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Origin of Cosmic Ray Stars at Sea-Level

IN an effort to identify the radiation responsible for production of the nuclear disintegrations and heavy charged particles occurring in the cosmic rays, we have carried out experiments with Ilford 'Nuclear Research' emulsions exposed on high mountains, and at sea-level with various absorbing materials. The results may be summarized as follows.

The ratio R of the number of single tracks to disintegration 'stars' has been measured at different altitudes, the plates and packing being identical in each case:

	Sea-level	12,000 ft.	14,500 ft.
Relative intensity of stars	1	10	20
R	26 ± 3	27 ± 2	$23{\cdot}5 \pm 2$

The constancy of R immediately suggests that the single tracks arise from stars produced in the material adjacent to the emulsion. This assumption is borne out by the fact that the proportion of single tracks attributable to alpha-particles and protons is, in fact, about what would be expected from the observed ratio in stars in the emulsion. Alpha-particles, with about one quarter of the range of the protons, produce some 7 per cent of the single tracks and 30 per cent of the tracks from stars.

On the above assumption, it is possible to calculate the value of R as follows. In examining a star in the emulsion, the identification of the disintegrating nucleus can, of course, only be based on the total charge carried by the emitted particles. It is thus found that the disintegration of a carbon, oxygen or nitrogen nucleus appears to be roughly eight times as probable as that of silver or bromine. Observations have therefore been made on the range and frequency distributions of tracks from stars produced by disintegration of the light or heavy emulsion nuclei respectively, and these data used to calculate the value of R when materials of various atomic number are in contact with the plates. (The thickness of the layer is assumed large compared with the mean range of the particles from stars, which is ~ 1 mm.) Making allowance for the effect of the glass of the plate, our results are as follows:

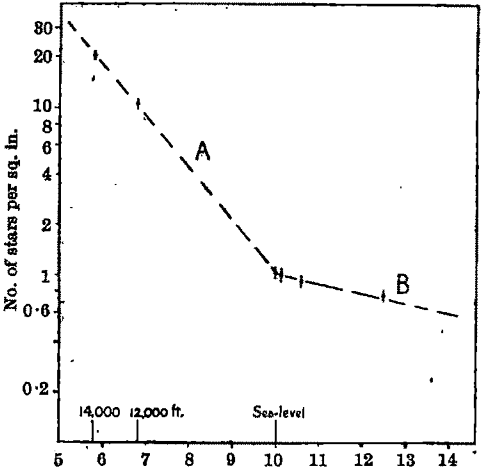
Covering material (1 cm. thick)	R (observed)	R (calculated)
Graphite	28 ± 2	~ 35
Paraffin wax	24 ± 2	~ 30
Brass	28 ± 4	~ 30
Lead	25 ± 2	~ 25

It is interesting to observe that there is no marked variation in the numbers of tracks with atomic number of covering material. Furthermore, the observed and calculated values agree as well as could be expected in view of the uncertainties in the calculation.

It can therefore be taken that the number of stars in the plate is proportional to the number of single tracks observed, and this fact has been used in order to obtain statistically significant results, in measuring the absorption coefficient of the star-producing radiation at sea-level. The variation in the number of single tracks (and hence presumably of stars) in plates exposed under different thicknesses of lead and paraffin wax was as follows:

Lead	Tracks per sq. in.	Paraffin wax	Tracks per sq. in
0·2 cm.	53 ± 5	1 cm.	49 ± 5
1 "	50 ± 5	5 "	56 ± 7
5 "	46 ± 5	17 "	51 ± 5
20 "	38 ± 3		

The data for single tracks under lead enables us to compare (see graph) the absorption of the star-producing radiation in a given mass of atmosphere (in metres of water-equivalent) with that in the same mass of heavy matter; clearly the former is much greater[1].



(*A*) ABSORPTION OF STARS IN THE ATMOSPHERE. (*B*) ABSORPTION OF SINGLE TRACKS IN LEAD

From the above facts, and the absolute intensity of stars (~ 1 per c.c. 'Nuclear Research' emulsion per day) and single tracks (~ 0·3 per sq. cm. per day) at sea-level, we can make certain deductions regarding the nature of the star-producing radiation.

Bagge[2] has attributed the stars to photons; but although the altitude variation of stars ($I = I_0$ exp ($- 1{\cdot}17h$), where h is in metres of water) is almost identical with that of the soft component, the cross-section for photonuclear disintegration would have to be $\sim 2 \times 10^{-25}$ cm.^{2} to account for the observed star intensity; this seems impossibly high. Further, the weak absorption in lead shows the star-producing radiation to be far more penetrating than photons. Heitler, Powell and Heitler[1] observed a 50 per cent increase in the intensity of the single tracks under lead at the Rossi maximum (1·2 cm.) on the Jungfrau, but the present experiments show that, if such an effect exists at sea-level, it is less than 10 per cent. It is also noteworthy that in cloud-chamber work[3] there has been a significant absence of correlation between stars and cascade showers. From these facts one concludes that photons produce only a small proportion (less than 10 per cent) of the stars.

It has also been suggested that neutrons are largely responsible for the stars. It will be seen from the table, however, that covering the plates with layers of hydrogenous material does not noticeably increase the number of single (proton) tracks, and a similar effect is observed at high altitudes. We are thus able to fix an upper limit to the flux of fast neutrons across the plates, and find it to be less than half per cent of the total radiation at sea-level. Assuming the capture of fast neutrons to be responsible for nearly all the stars, this in turn puts a lower limit to the cross-section for this process. One finds $\sigma \geqslant 2 \times 10^{-24}$ cm.^{2}, which appears quite irreconcilable with the small absorption coefficient in lead. We therefore conclude that neutrons cannot account for more than about 10 per cent of the stars.

Although it is almost certain that several different types of radiation play a greater or lesser part in star production, the rapid absorption of this radiation in the atmosphere, as compared with dense matter, strongly suggests that a large proportion of the disintegrations are initiated by unstable particles undergoing radioactive decay in free space. Again, in cloud chamber experiments, events in which charged particles produce stars are comparatively rare. Furthermore, the intensity of charged mesons appears to increase only slowly with altitude. It is therefore probable that the particles responsible for the stars are uncharged.

The only reasonable alternative is to suppose that the star-producing radiation at high altitudes is quite different from that at sea-level.

I am indebted to Prof. L. Leprince-Ringuet for kindly exposing the plates at high altitudes, and to Sir George Thomson for valuable discussions and advice.

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Oct. 23.

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Solar Radio-Frequency Noise Fluctuations and Chromospheric Flares

Martyn[1] and Shklovsky[2] have suggested that plasma oscillations in the corona may provide a source of radio-frequency radiation. It has also been shown that radiation of a few metres wave-length must originate at heights above the chromosphere of the order of a solar radius.

If the plasma is excited by ultra-violet radiation, noise fluctuations should occur simultaneously with flares. If corpuscular emission is responsible, the radio noise should be observed later than the flare by an interval dependent on the average velocity of the corpuscles and the height at which the oscillations are excited.

Observations of radio noise at 75 Mc./s. made here during the past few months, combined with solar flare and radio fade-out data made available by the Commonwealth Observatory, Canberra, and the Watheroo Magnetic Observatory, provide the instances, collected in the table, of a delay of the right order between chromospheric disturbance and noise bursts.

The disturbances of 16.5.47, 4.6.47 and 5.6.47, described as 'violent', consisted of numerous bursts with a very high flux-level and a duration longer than the usual noise storm.

During the same period, and within the interval (02.00–06.00 G.M.T.) of observations at Perth and the half-hour preceding, five flares of importance 0–1 and three noise storms considered to be associated with simultaneous (but unobserved) chromospheric disturbances were reported from Canberra and three minor fade-outs from Watheroo. No radio noise was observed in connexion with these disturbances.

Appleton[3] and Allen[4] have observed noise fluctuations occurring simultaneously with flares or fade-outs. Appleton's observations were made at a time when the quasi-steady background flux was abnormal, that is, when the plasma was continuously excited. In such conditions ultra-violet radiation might be more effective. Allen's observations, made on 200 Mc./s., apply only to a proportion of flares and bursts and are not inconsistent with those tabulated here.

Some time ago[5], I reported observations of violent fluctuations in solar noise flux (03.14–29 G.M.T. on 2.8.46) at the same time as an eruptive prominence was seen at Watheroo to develop and fade on the solar limb. Since the Watheroo observations did not begin until 03.15 G.M.T., the possibility exists that the initial flare occurred sufficiently beforehand for corpuscular emission to have been responsible for the radio noise. On that occasion there was no fade-out, but another noise disturbance on 2.8.46, observed during 04.51–7 G.M.T., was preceded by a fade-out at 04.45, observed to be connected with another disturbance in the same region of the sun. Since the origin of the noise radiation is thought to be high in the corona—probably exceptionally high over the large sunspot group then on the limb—it would appear that serious absorption of the radio-frequency radiation did not occur in the direction pointing to the earth at that time, although normally conditions would

Date	Chromosphere		Radio noise (Perth)			
	G.M.T.	Observatory	Simultaneous	Intensity	Delayed	Intensity
7.3.47	05.00	Fadeout, Watheroo	G.M.T. nil	—	G.M.T. 05.20	single burst
14.3.47	03.00	Fadeout, Watheroo Flare, Canberra	03.02	very slight	03.14–16	many bursts, marked
2.4.47	01.57	Flare, Canberra	Observing from 02.00; quiet until 02.24			many bursts, marked
29.4.47	01.54–02.13 02·00	Flare, Canberra Fade, Canberra	nil	—	03.01	small
16.5.47	03.00	Fade, Watheroo	02.59–03.00 08.03–03.08	small but distinct	03.28–40	violent
21.5.47	04.45	Fade, Watheroo	nil	—	04.56	several bursts
21.5.47	01.30–43	Flare, Canberra	Observing from 02.00		02.12	single large burst
4.6.47	03.00	Fade, Canberra	nil	—	03.04–05 03.10–23	a few bursts* violent
5.6.47	02.20	Fade, Canberra	nil	—	02.37–03.02	violent†

* Noise at 03.04–8 on 200 Mc./s., observed at Canberra.
† Noise at 02.37–9 and 03.02–8 on 200 Mc./s., observed at Canberra.

not be favourable for observations of disturbances so far (80° W.) off the central meridian.

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[2] Shklovsky, *Nature*, 159, 752 (1947).

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[4] Allen, private communication.

[5] Williams and Hands, *Nature*, 158, 511 (1946).

Photo-electric Fourier Transformer and its Application to Sound-Films

At the time of the publication of the accounts by Born, Fürth and Pringle[1,2] of the new instrument named by them the 'photo-electric Fourier transformer', we happened to be engaged in constructing a very similar instrument here. The principle of the apparatus and the main essentials of its design had been worked out by one of us (D. B.) in continuation of earlier work on acoustic spectra from sound-films; it seemed probable that the method would have advantages over the diffraction method previously employed[3].

Between our arrangement and that of the above authors the only significant differences are as follow. (*a*) We do not employ masks or silhouettes representing the functions to be analysed, as it has always been our aim to use actual sound-film. (*b*) Instead of producing the Fourier transforms of given functions singly, we seek to produce a continuous or running analysis as one function changes by gradual transitions into another. Our apparatus, therefore, includes a provision for moving the record of the function A (that is, the sound-film) steadily past the optical aperture, and simultaneously moving the photographic film B upon which the transformed function is recorded or transcribed. (*c*) The signals from the photocell are employed to give intensity modulation on the oscillograph screen instead of amplitude modulation; this is necessitated by (*b*) above. (*d*) In view of the fact that the higher audio-frequencies are registered on a sound-film as extremely fine periodicities indeed, we employ a grating with a greater number of more closely spaced elements; our grating is in the form of a disk 6 in. in diameter with 55 elements to the inch.

In other respects, such as the general arrangement of the disk, slit, photocell and oscillograph, and the use of a harmonic time-base synchronized electromagnetically with the rotating disk, our method coincides surprisingly closely with that of the above authors.

Early attempts to produce a satisfactory disk were made during the war period, but the work had then to be abandoned for more urgent matters. Shortly after the project was resumed, the paper of Born, Fürth and Pringle appeared, but we continued our work as we had a somewhat different object in view in constructing the instrument. Incidentally, when this is to be used to analyse actual sound-film, the requirements of the optical and amplifier systems become very stringent, presenting problems which could not be overcome immediately. The accompanying photographs show, however, that it is possible, using this apparatus, to display sound in the desired way. When a film record of speech sound is subjected to analysis, a succession of frequency-versus-time patterns is obtained, of the type illustrated by Fig. 1, which represents the word 'there', containing the diphthong ɛ + ə. From previous knowledge, the acoustic spectrum would be expected to show a considerable number of harmonics of the vocal-cord pitch, with certain of the harmonics augmented in intensity by the resonances of the vocal cavities, and we find these characteristics clearly brought out in the photograph. Some pre-distortion in favour of the higher frequencies was employed during recording, and for this reason, and because of its low natural intensity, the fundamental pitch itself is not registered in this trace.

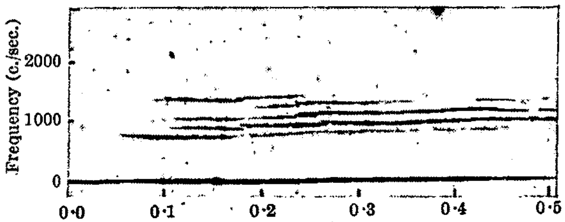

Fig. 1

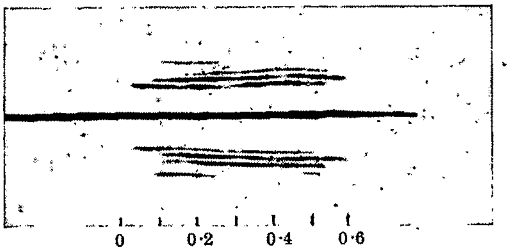

Fig. 2

The zero-frequency line in the record is produced by the steady component of the light transmitted by the sound film. Neglecting small phase-difference effects, the oscillograph pattern is symmetrical about this line, so that if the whole pattern is photographed, the effect is as shown in Fig. 2, which is derived from the same initial film record as Fig. 1. Also, Fig. 2 illustrates the effect of using a smaller velocity for the film B in transcribing, so that the time-scale is more compressed. The changes in the vocal resonance regions, also the swing of the harmonic frequencies away from the axis, due to rising pitch inflexion, are now more easily appreciated by the eye.

It is not proposed to discuss here possible applications of this method of presenting vibration phenomena, which, of course, need not be limited to acoustic vibrations. In the field of communications, reference may be made to the recent survey by Gabor[4]. Also, while the present work was in progress, a series of articles has appeared[5] describing some remarkable recent developments in the Bell Telephone Laboratories, and their applications. The sound-spectrograph there described achieves in a striking manner the result aimed at in our own investigations, a fuller account of which will be published elsewhere. In conclusion, we wish to acknowledge great assistance from Mr. C. F. Coleman in the conduct of these experiments.

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July 31.

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Influence of Water on the Lubrication of Metals

EARLIER work[1] has shown that the simple physical adsorption theory of boundary lubrication is inadequate; fatty acids are not really effective in lubricating metals unless they are able to react chemically with the surface to form the metallic soap. Gregory's measurements have shown, for example, that platinum is not effectively lubricated by a dilute solution of a fatty acid, whereas cadmium is lubricated up to the temperature at which the appropriate cadmium soap softens. Using a variety of metals he found a general relation between lubrication and chemical attack of the metal. With many metals, the chemical reaction of the fatty acid to form the soap occurs via the surface oxide film or in the presence of oxygen[2]. If this view is correct, we should expect that fatty acids would not prove effective lubricants even on metals such as iron or cadmium if oxygen is excluded.

Experiments were carried out on the lubrication of metal surfaces which were freed from oxide and surface films by cutting a fresh surface under the applied lubricant. The Bowden–Leben[3] friction apparatus was used throughout. By means of a specially designed cutting tool, a smooth shallow track was laid bare on the lower metal surface immediately before its passage under the loaded hemispherical slider used to measure the force of friction. The results show at once that a 1 per cent. solution of lauric acid in paraffin oil is no more effective in lubricating the freshly cut metal surface than the paraffin oil itself. Further, if the lubricant is left on the surface for several hours, the lubrication remains poor, and this is true even if the temperature is raised to 100° C.

In other experiments, newly cut tracks were exposed to air for varying periods up to 24 hours; attempts were then made to lubricate them with the fatty acid solution. In the case of copper, lubrication was still ineffective even after 24 hours exposure. Magnesium and cadmium showed the same effect although to a lesser degree. In all cases, however, if the newly cut track was made wet with distilled water and allowed to dry before application of the lubricant, or was exposed to an atmosphere saturated with water vapour, good lubrication was immediately obtained. For effective lubrication, it is apparently necessary for *water* to have been present as well as oxygen.

In a series of corroborative experiments, the metal surfaces were abraded on emery paper under carefully dried benzene and kerosene, the lubricant being applied without allowing contact with the atmosphere. Here, again, the fatty acid solution was unable to provide good lubrication. Exposure of surfaces prepared in this way to distilled water in air caused lubrication to be effective.

Copper surfaces prepared in the normal way by abrading on emery paper under a stream of water are readily lubricated. A surface prepared in this way was heated to 200° C. and maintained at this temperature until an oxide film thick enough to give interference colours was formed. The specimen was then cooled in a vacuum desiccator to room temperature and treated with fatty acid solution. No lubrication was obtained. On covering an identically prepared oxide layer with a film of distilled water for one minute and then drying, the same fatty acid solution gave a low coefficient of friction.

Treatment of surface	Lubricant	Coefficient of friction (μ)		
		Copper	Cadmium	Magnesium
Abraded on emery under water.	1% lauric acid in paraffin oil	0·08	0·05	0·08–0·11
"	Paraffin oil	0·55*		
Oxide film removed by scraping under lubricant	1% lauric acid in paraffin oil	0·9–1·4*	0·35–0·45*	0·40*
"	Paraffin oil	0·75–1·15*	0·50*	
Abraded on emery under dry kerosene	1% lauric acid in paraffin oil	1·20*	0·30*	0·44–0·48*
"	Paraffin oil	>1*		0·46–0·50*
Thick dry oxide film formed by heating	1% lauric acid in paraffin oil	0·8–1·0*		
Ditto, exposed to water and dried	1% lauric acid in paraffin oil	0·08		

In all cases, the load on the slider was 4 kgm. and the speed of the lower surface 0·01 cm./sec.; * denotes irregular or intermittent motion.

The main results are summarized in the table.

The results provide additional evidence for the view that chemical reaction, with the formation of a soap film, is necessary for the effective lubrication of metal surfaces by fatty acids. The second conclusion of theoretical and practical interest is that water may play an essential part in this chemical reaction.

The role of water has a number of possible explanations. It may be that it leads to the formation of a loose hydroxide or hydrated oxide layer of a character suitable for penetration and reaction by the acid. Alternatively, water may facilitate a local ionization of the acid molecules at the seat of reaction.

I wish to express my thanks to Dr. F. P. Bowden and Dr. D. Tabor for helpful discussions.

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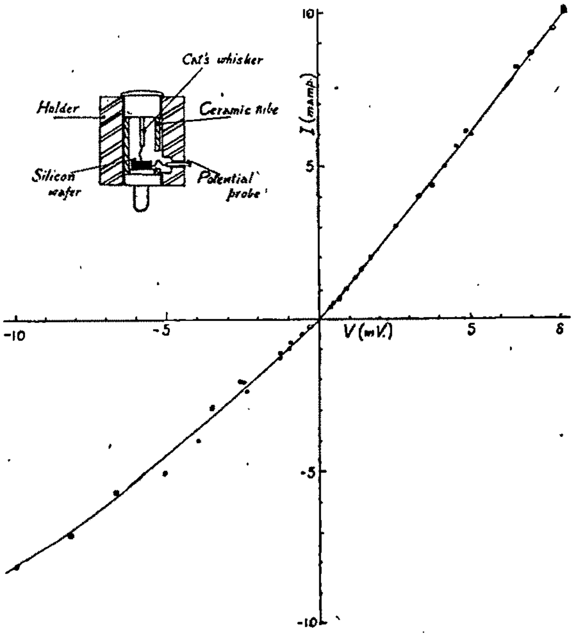
A Silicon-Metal Contact Resistance

THE rectifying action of a silicon crystal valve is a property of the contact between the silicon and a metal 'cat's-whisker'. In order to complete the circuit it is necessary to have a second silicon–metal contact the resistance of which must be small compared with that of the rectifying contact, so that the rectifying action is not cancelled out by the second contact.

It is usually assumed that the resistance of this second contact is negligibly small. During some recent measurements of silicon–metal contact resistances, an attempt was made to measure the value of this resistance in a commercial rectifier. The results showed that the resistance was small and could be neglected for most practical purposes, but it was large enough to introduce an error in determination of the crystal 'spreading resistance'[1] from the overall characteristics.

The crystal used was a *C V* 253 the performance of which lay within the normal spread. This type was chosen because its mechanical construction was convenient for the measurement. In this crystal a piece of silicon about 2 mm. square and 0·5 mm. thick is soldered to a brass pin which is fixed in one end of a ceramic tube. A brass cap is fixed in the other end of the tube. The cat's-whisker is fixed in the brass cap and presses on the surface of the silicon to make the rectifying contact. A hole was cut in the ceramic tube opposite the silicon, and a second cat's-whisker was inserted through this hole to make contact with the side of the silicon wafer. For mechanical stability the crystal and the second cat's-whisker were fixed in an insulating holder. The second cat's-whisker was used as a potential probe so that by taking a potential lead from the crystal-pin the resistance of the 'good' contact could be measured with a potentiometer.



The results are shown in the graph. This is a current-voltage characteristic for the 'good' contact and is the mean of three sets of readings taken over an interval of about a fortnight. The graph shows that the contact has a resistance of about 1 ohm and is slightly smaller when the current flows from pin to silicon across the contact than when the current flows in the reverse direction. This direction of low resistance is the reverse of that for the rectifying contact of the crystal. It does not seem that this resistance could be attributed to the silicon itself because the resistivity of the silicon will be about 0·1 ohm-cm., so that the piece in the crystal should have a resistance of less than 0·1 ohm.

While the 'good'-contact resistance is small, it is not negligible compared with the 'spreading' resistance, which for silicon crystal valves is usually in the region of 20–50 ohms. To check this conclusion, the forward characteristic of the crystal was measured in the usual way, and then measured using the second cat's-whisker as a probe in the same way that the 'good'-contact resistance was found.

The spreading resistance was estimated by putting $R_s \doteqdot \delta V/\delta I$, where δI is the change in current produced by a change in voltage δV when a large current I is flowing through the crystal. The results found for the crystal used were: from overall characteristic $R_s = 59 \cdot 5$ ohms, using cat's-whisker probe $R_s = 58 \cdot 5$ ohms. These results agree with the measurements of the 'good'-contact resistance.

One cannot expect to draw more than very general conclusions from a single measurement of this sort. It does seem worth pointing out, however, that an effect exists which is not completely negligible and is, in fact, large enough to affect accurate measurements of the spreading resistance, which are sometimes necessary in studying the performance of rectifiers. It is possible that this effect might cause more serious errors in germanium rectifiers, where the spreading resistance may be so low as 1–2 ohms.

While it is reasonable to expect the contact resistance for germanium also to be reduced in the same proportion, it would seem desirable to check this in view of the conflicting results obtained with germanium crystals.

I wish to acknowledge the financial assistance given by the Department of Scientific and Industrial Research which made the work possible.

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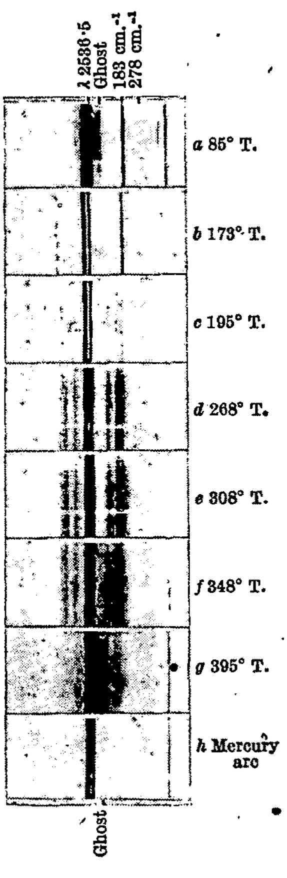
Vibration Spectra of the Alkali Halides

As is well known, ammonium chloride crystallizes in the cubic system, its structure being of the rock-salt type above 450° T. and of the cæsium chloride type below that temperature. Menzies and Mills[1] found that at liquid air temperatures it shows in its Raman spectrum a strong line with a frequency shift of 183 cm.$^{-1}$. This observation is significant, since the frequency shift corresponds to the *Reststrahlen* frequency of the crystal[2] and hence indicates that the oscillation of the NH_4 groups against the Cl ions is Raman-active. The crystal powder technique employed by Menzies and Mills is, however, not well suited for the study of Raman spectra in the region of such small frequency shifts. Accordingly, a fresh investigation has been made with a well-grown single crystal and the λ 2536·5 excitation and the same technique as in my recent investigations with various other crystals. To enable the entire sequence of changes to be observed, spectra were recorded with the crystal held at a series of seven temperatures down to that of liquid air.



The series of spectra reproduced, while confirming Menzies and Mills' results for the liquid air temperature, reveals numerous other interesting facts. The spectrum becomes diffuse and faint when the crystal is heated up above room temperature. *Per contra*, when the crystal is cooled down, the spectrum brightens and also sharpens remarkably, exhibiting even above the so-called λ-point transition (243° T.), a group of three fairly well-defined Raman shifts of 92, 141 and 170 $cm.^{-1}$ respectively, with indications of two fainter ones at 107 and 195 $cm.^{-1}$. These persist far below the λ-point transition, becoming at the same time quite sharp and showing a progressive shift in their position with falling temperature. A remarkable change in their relative intensities also occurs at the same time. At liquid air temperatures, a new line with a frequency shift of 278 $cm.^{-1}$ unmistakably makes its appearance. This is quite sharp but faint.

There can be little doubt that the features seen in the spectra reproduced arise from oscillations of the lattice in which the NH_4 groups may be considered to move as single units and that, with the exception of the 278 $cm.^{-1}$ line, they represent the first-order vibration frequencies of the lattice. The observed discrete character of the spectrum and the sharpening of the lines with falling temperature are both in accord with the fundamental ideas regarding the vibration spectra of crystal lattices put forward by Sir C. V. Raman[3] and are, therefore, experimental evidence of his theory. That the vibration frequencies in this case are Raman-active in the first order, instead of being inactive as in the metallic halides, is evidently a consequence of the NH_4 group possessing only tetrahedral symmetry as compared with the octahedral symmetry of the metallic ions.

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Electron Microscope Investigation of the Action of Salt Solutions on Myosin

IN previous work it was shown that the thiocyanate anion (0·05 mol. solution of sodium thiocyanate), which produces monsters with large notochord and hyper-evocation in Amphibia embryos[1], also induces a decrease in viscosity of solutions containing euglobulin *b*[2]. On the other hand, lithium chloride induces an increase in viscosity of these solutions, at a concentration (0·14 mol.) which produces monsters with reduced notochord and hypo-evocation. A similar effect has been found for the viscosity of solutions containing fibrillar particles (myosin, sodium thymonucleinate)[3]. In order to find what kinds of modifications were induced by the various salts in the myosin solutions, an investigation with the electron microscope was undertaken.

Rabbit myosin, prepared according to the methods previously used, was dissolved in a 1-mol. solution of potassium chloride, to which was added: (*a*) nothing; (*b*) sufficient of a 1-mol. solution of potassium thiocyanate (or iodide) to bring the concentration of thiocyanate (or iodide) to 0·5 mol.; (*c*) sufficient of a 1-mol. solution of lithium chloride to bring the concentration of lithium salt to 0·14 mol. After twelve hours at 0° C., these solutions were examined by means of the electron microscope, on preparations fixed and stained for one minute with 0·1 per cent phospho-tungstic acid, according to the method of Hall, Jakus and Schmitt[4].

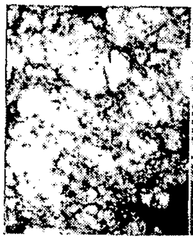

Fig. 1

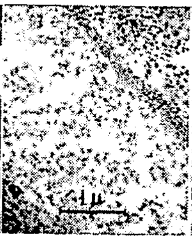

Fig. 2

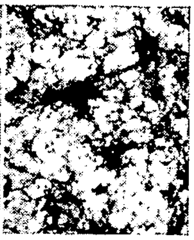

Fig. 3

Preparations of myosin dissolved in potassium chloride alone (*a*) show clearly a fibrillar structure (Fig. 1); those treated according to (*b*) show the loss, sometimes even total, of the fibrillar structure (Fig. 2); those treated according to (*c*) show clearly a fibrillar structure. This is in full agreement with the finding of a lower viscosity of the myosin solutions after addition of potassium thiocyanate (or iodide)[3], and of loss of flow birefringence in myosin solutions when treated with these salts[5]. It is also in agreement with the finding of a higher viscosity of myosin solutions by addition of lithium chloride (up to a final concentration of 0·25 mol.[3]) and of flow birefringence of myosin solutions in lithium chloride[5].

It is difficult, now, to establish the relations between our findings and those of Jakus and Hall[6] on solutions of Szent-Györgyi's water-soluble myosin. The filaments of this myosin, by increase of the concentration of potassium chloride in the solvent, are transformed into a granular background and, if the salt concentration is then lowered, the myosin re-aggregates: our myosin is Weber and Edsall's myosin, that is, distinct from water-soluble myosin.

The present researches show that the effect of the thiocyanate anion on a fibrillar protein such as myosin, as shown by the electron microscope, is quite different from that of lithium chloride, in agreement with what could be expected from our viscosimetric researches[2,3].

I am grateful to Prof. D. Marotta, general director of the Istituto Superiore di Sanità, Prof. G. C. Trabacchi, director of the Physics Department, who supervised the work done with the electron microscope, which was constructed by him, and to Prof. D. Bocciarelli, who took the photographs.

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Plasma-Electron Oscillations

During the past ten years, a series of investigations on the generation of high-frequency oscillations in thermionic tubes containing gas at low pressure has been made in this laboratory. The vacuum electromagnetic wave-lengths involved, usually well below 100 cm., and the conditions under which they appear, are in the main consistent with the view that they are plasma-electron oscillations with frequency approximately equal to $10^4 n^{1/2}$ (n is electron concentration), originating near the cathode[1,2]. The shortest wave-length which can be obtained is, however, not about 15 cm., as indicated by previous publications, but 5 cm. or less. Whatever its exact value, this is likely to be determined by the damping of the oscillatory motion of the electrons by collisions with ions when the ionization is very dense, or by collisions between electrons and gas-molecules at the gas-pressures necessary to produce high electron concentrations readily.

The amplitude and wave-length of the oscillations which can be transmitted to an external circuit depend markedly on position on the current-voltage characteristic of the generating tube. With an oxide-coated cathode, oscillations can usually be detected over wide sections of the characteristic. With a bare filament cathode, the oscillation regions are much more restricted. Often there will be one oscillation region in the infra-saturation section, one at about the saturation 'knee', and a third in the saturation section some volts above the 'knee'. No tube which has been studied containing gas at less than 0·01 mm. mercury pressure failed to generate oscillations over some part of its characteristic curve.

The amplitude of the oscillations which can be detected by an internal probe depends considerably on the position of the probe, but the wave-length of the oscillations does not usually change much as the probe is moved. A number of amplitude-distance patterns like those reported by Merrill and Webb[3] have been obtained; these, taken in conjunction with the fact that on a number of occasions when a discrete beam of primary electrons could be observed, oscillations could be picked up by the probe only when the beam struck the probe, provide evidence that at least one of the processes operative is velocity modulation of the primary beam in a comparatively small volume of oscillating plasma. From the variation of frequency along the saturation part of the characteristic, it seems that the position of the oscillating volume near the cathode is not constant. There is also evidence that two volumes of plasma with different electron concentrations may oscillate simultaneously and independently, from the fact that a probe will occasionally pick up different frequencies in different parts of a tube[4]. This is in agreement with the theory of plasma electron oscillations, according to which the group velocity of the oscillations is almost zero[2].

The amplitude of the oscillations which can be obtained externally depends a great deal on electrode geometry, and upon the electrode to which the external circuit is connected. Thus with a simple coaxial electrode system with open ends, by far the strongest oscillations can be set up in a coaxial resonator if the central rod of the latter is joined end-on to the negative end of the filament, and if the filament is held taut and projects a little beyond the end of the anode. There is evidence that effects of this kind are connected in some cases with the movement of the electrons in the magnetic field of the filament-heating current, as the response of the resonator is reduced greatly by eliminating this. Further evidence for the existence of magnetic control is that an asymmetrical tube which normally gives feeble oscillations can be caused to give strong oscillations by bringing a bar magnet near it.

The way in which the plasma-electron oscillations are maintained is still not clear. One obvious possibility is that this is due to interaction between the primary electron beam and the plasma electrons, which depends on their relative speed, but the effects of magnetic fields suggest that some process which occurs with magnetrons may also come into play. It is also possible to draw an analogy between gas-filled diodes and 'hard' triodes giving Barkhausen – Kurz oscillations, with a potential maximum in the plasma of the gas taking the part of a positive grid in a 'hard' tube; it is, in fact, known from optical observations and probe measurements in some gas-filled diodes that a region of plasma with unusual properties extends outside the space-charge sheath on the filament for several times the diameter of the latter. Another possibility, suggested by Prof. K. G. Emeléus, is that plasma-electron oscillations outside the filament space-charge sheath are coupled with oscillations inside the sheath in which the potential minimum near the cathode forms and disappears discontinuously. With the complex conditions existing inside even the tubes of simple construction which have been studied, it would not be surprising if more than one of these effects, or others not considered here, should have to be taken into account ultimately.

The work described above has been carried out on behalf of the Director of Physical Research, Admiralty, and I wish to express my thanks to the Admiralty for permission to communicate these results.

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Angle of Incidence of the Sun's Rays

The radiant heat from the sun received by each square foot of ground affects a number of questions, such as evaporation from the soil, the growth of close-growing crops, and snow conditions. One of the factors involved is (the sine of) the angle of incidence of the sun's rays; and calculation of this angle, according to aspect and inclination of hillside, and sun's bearing and altitude, may necessitate the solution of many spherical triangles; so the following short cut may be worth noting.

The angle of incidence on a slope at S is equal to the angle of incidence on the parallel plane touching the earth at T, the nearer of the two possible tangent points. As this parallel plane corresponds to the level surface at T, the sun's altitude at T is the angle required; and if the position of T can be found, that angle can be read directly from altitude (-azimuth) tables, without worrying about spherical triangles, or even azimuth.

But the problem is to find T. It lies on the great circle through S, the course of which at S corresponds

ANGLE OF INCIDENCE OF SUN'S RAYS

Slope		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	= Aspect
40° N.	Lat.	86	81·5	76	70	63·5	57	51	45	39	33·5	
	d Long.	0	3·65	4·35	4·55	4·5	4·3	4·1	3·85	3·65	3·35	
40° S.	Lat.	6	7	8	10	12·5	15·5	19	23	28	33·5	
	d Long.	0	0·4	0·85	1·25	1·65	2·05	2·45	2·75	3·0	3·35	

Lat. in degrees and decimals. *d* Long. in hours and decimals. Aspect is measured from N–S line. If it is easterly, *d* long. is plus; if westerly, minus.

to the aspect of the slope; and its angular distance from *S* is equal to the inclination of the slope. This great circle, and the latitude of *T*, and its *d* long. from the meridian of *S*, can be deduced from Towson's "Tables for Great Circle Sailing", which embody the solution of appropriate spherical triangles—if what Towson calls 'course' is interpreted as aspect, and what he calls 'distance' is interpreted as inclination. As the great circles are symmetrical about the meridian of *S*, the same values will serve for easterly and westerly aspects, provided that the correct signs are used when calculating hour angles.

Once the positions of *T*, according to aspect and inclination of slope, have been tabulated for a given latitude of *S*, the resulting figures can be used for any time of year, and any hour of day. Further, the times at which the slope at *S* gets and loses the sun, if it does so after sunrise or before sunset, will be simultaneous with sunrise and sunset at *T*.

To give an example, the accompanying figures from the table for lat. 46° N. will apply to the Alps, as they lie between 45° and 47° N.

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Random Association of Points on a Lattice

MORAN[1] has given the first and the second moments for the probability distribution of 'black – white' joins when *mn* points black or white with probabilities p and $q = 1 - p$ respectively are distributed on a lattice of *m* rows and *n* columns. During the course of a detailed study of similar problems, I have worked out the first and the second moments for the distribution of the total number of joins between points of different colours when the lattice consists of points of *k* colours with probabilities $p_1, p_2 \ldots p_k$, such that $\sum_1^k p_r = 1$. These results for one, two and three dimensions are given below:

(1) One-dimensional lattice: *m* points on a line:

$$\mu_1^1 = 2(m-1)\,\Sigma p_r p_s$$
$$\mu_2 = 2(2m-3)\,\Sigma p_r p_s + 2(14-9m)\,\Sigma p_r p_s p_t + 4(5-3m)\,\Sigma p_r^2 p_s^2 + 8(3m-5)\,\Sigma p_r p_s p_t p_u$$

(2) Two-dimensional lattice: $m \times n$ points:

$$\mu_1^1 = 2(2mn-y)\,\Sigma p_r p_s$$
$$\mu_2 = 2(8mn-7y+4)\,\Sigma p_r p_s - 4(19mn-17y+10)\,\Sigma p_r p_s p_t - 4(14mn-13y+8)\,\Sigma p_r^2 p_s^2 + 8(14mn-13y+8)\,\Sigma p_r p_s p_t p_u$$

(3) Three-dimensional lattice: $l \times m \times n$ points:

$$\mu_1^1 = 2(3lmn-x')\,\Sigma p_r p_s$$
$$\mu_2 = 2(18lmn-11x'+4y')\,\Sigma p_r p_s - 2(87lmn-54x'+20y')\,\Sigma p_r p_s p_t - 4(33lmn-21x'+8y')\,\Sigma p_r^2 p_s^2 + 8(33lmn-21x'+8y')\,\Sigma p_r p_s p_t p_u,$$

where $y = m+n$, $x' = lm+mn+nl$, $y' = l+m+n$. The summations are taken for all values of *r*, *s*, *t* and *u* different from one another. The joins considered are those along mutually perpendicular axes.

It can be shown that the distributions tend to the normal form when *m*, *mn* and *lmn* are increased.

The corresponding results when the lattices consist of $n_1, n_2 \ldots n_k$ fixed numbers of points from the different colours have also been worked out. These results, being more complicated, will be given in a detailed communication to be published shortly.

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Micro-Estimation of Sugars Separated on the Filter Paper Chromatogram

IN view of the recent communication from Flood, Hirst and Jones[1] on this subject, a description of a method developed in this laboratory may be of interest. The same principle is used for the separation of sugars in a mixture, but a different method of extracting the separated sugars from the paper is employed, and the final estimation is carried out by a micro method free from the disadvantages associated with the Somogyi method and gives directly the weight of the sugar without the use of a reference compound. Certain of the established microchemical techniques developed in the Carlsberg Laboratory[2] are employed, and the scale of the method is correspondingly reduced. The procedure is, briefly, as follows.

By means of an accurately calibrated micro-pipette, replicate spots of known volume (4·05 µl. throughout these experiments) of the solution of sugars are placed at intervals of 3 cm. on the starting line of a filter-paper chromatogram, and the separation of the sugars is carried out as described by Partridge[3], care being taken to ensure that the solvent front remains straight and at right angles to the edge of the paper. The bulk of the solvent is then removed from the chromatogram *in vacuo*, a strip (on which will lie one complete set of the separated sugar spots) is cut from the paper and the position of these spots is revealed by development with ammoniacal silver nitrate.

Using this reference strip as a guide, the main portion of the chromatogram is then cut so that the individual sugar spots lie on pieces of paper approximately 3 cm. × 7·5 cm. long which are trimmed to a point, the sugar spot lying about 1 cm. from the tip. The subsequent treatments are also applied to blank pieces of the same size.

The pieces containing the sugars are freed from the chromatographic solvent by extraction in a Soxhlet condenser with anhydrous ether (petroleum ether, b.p. 60–80°, if xylose is present). The individual sugars are then washed off the pieces by a procedure analogous to the chromatographic separation, but using distilled water in place of the chromatographic solvent. The dilute sugar solutions are collected in micro-pipettes, the tips of which rest against the points of the filter paper strips. (This method of extraction was suggested by Dr. A. J. P. Martin.) The solutions are transferred from the pipettes to cups cut in a block of paraffin wax, a total of 0·3–0·4 ml. of solution being collected from each paper. The solutions are then evaporated to dryness over phosphorus pentoxide.

To the paraffin cup 17 µl. of bicarbonate buffer pH 10·6 is added from a micro-pipette and the sugar dissolved with the aid of a fine, ball-tipped glass needle. The drop of sugar solution is then transferred by means of the same pipette to a waxed reaction tube[4]. Two further portions, each of 17 µl., of buffer are used to rinse the paraffin cup, the needle and the pipette, and are transferred in turn to the main solution in the reaction tube.

The estimation of the sugar is then carried out by the micro modification of the Willstätter and Schüdel method (stoichiometric oxidation by hypoiodite and titration of the excess iodine with thiosulphate) developed by Linderstrøm-Lang and Holter[4], oxidation being allowed to proceed for 45 minutes at 24° C.

Typical results obtained with a number of sugars using butanol-acetic acid-water[3] as the chromatographic solvent are given in the accompanying table, the figures quoted being the averages of four to six results from replicate spots run on the same paper.

Expt.	Sugars in mixture	R_F[3]	Taken (µgm.)	Found (µgm.)	Error %
1	Glucose	0·18	44	46	+ 4·5
	Lactose	0·09	76	76	0
2	Glucose	0·18	57	59	+ 3·5
	Lactose	0·09	107	105	− 2
3	Galactose	0·16	81	73	−10
	Maltose	0·11	94	91	− 3
4	Mannose	0·20	42	40	− 5
	Xylose	0·28	42	40	− 5

In its present form the method is capable of separating and estimating with an accuracy of about ± 5 per cent as little as 40 µgm. of a sugar, though the error of a single estimation is about twice as great. The Linderstrøm-Lang and Holter method of estimating sugars, however, is capable of estimating quantities of the order of 10 µgm. with a high degree of accuracy, and the present technique should be capable of refinement to allow of the separation and estimation of quantities of sugars of this order.

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Hydrolysis of Bi^{3+}. Oxygen Bridging—a New Type of Ionic Equilibrium

It is well known that the ion Bi^{3+} easily reacts with water (is hydrolysed) so that hydrogen ions are set free. Very little is known, however, of the nature of the reaction products. In 1936 Holmqvist[2], and Prytz and Nagel[4] working independently, concluded that there are certainly not only mononuclear complexes ($BiOH^{2+}$, BiO^+) but also polynuclear complexes containing more than one bismuth atom. Holmqvist even tried to apply the law of mass action assuming definite formulæ, namely, $Bi_2(OH)_4^{2+}$ and $Bi_2(OH)_5^{+}$.

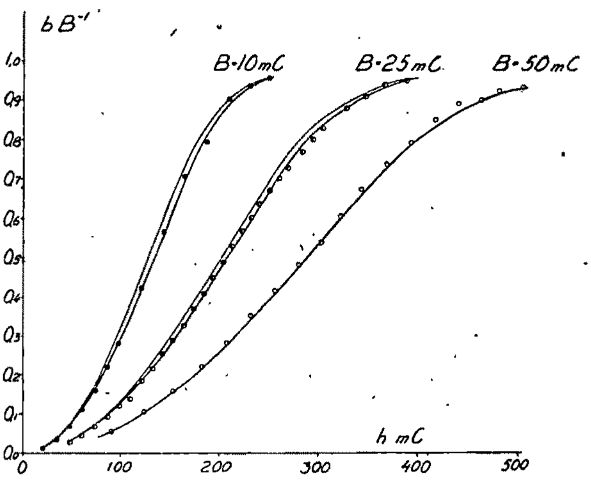


Fig. 1. $bB^{-1} = (Bi^{3+})_{free}/(Bi)_{total}$ AS A FUNCTION OF $h = (H^+)$. Circles = experimental values. The thick line for B = 50 millimol. and the thin lines for B = 25 and B = 10 millimol. are calculated with the constants $k_1 = 0·065$ and $k = 2·80$ mol. per litre. The thick lines for B = 25 and B = 10 millimol. are calculated with the best constants obtainable in each case: k_1 = 0·070 mol. per litre, k = 2·95 mol. per litre and k_1 = 0·060 mol. per litre, k = 3·15 mol. per litre

We have tried to measure accurately by E.M.F. methods the concentrations of free Bi^{3+} and H^+ in a series of solutions containing $Bi(ClO_4)_3$ or $BiOClO_4$, $HClO_4$ and $NaClO_4$ in such proportions that (ClO_4^-) is always equal to 3 mol. per litre.

Our results cannot be explained by assuming that only mononuclear complexes are formed, nor by assuming only one or two different polynuclear complexes. However, they agree surprisingly well with those calculated by assuming a simple mechanism ('oxygen bridging'):

$$Bi^{3+} + H_2O + Bi^{3+} = Bi_2O^{4+} + 2H^+ \qquad (1)$$

$$Bi_2O^{4+} + H_2O + Bi^{3+} = Bi_3O_2^{5+} + 2H^+ \qquad (2)$$

$$Bi_3O_2^{5+} + H_2O + Bi^{3+} = Bi_4O_3^{6+} + 2H^+ \qquad (3)$$

$$Bi_nO_{n-1}^{(n+2)+} + H_2O + Bi^{3+} = Bi_{n+1}O_n^{(n+3)+} + 2H^+ \qquad (n)$$

We assumed that the equilibrium constants of all these reactions are equal to k, except the first one which is called k_1. Fig. 1 shows the fraction $\frac{(Bi^{3+})\text{ free}}{(Bi)\text{ total}}$ as a function of (H^+); the experimental points are in good agreement with the curves obtained by assuming k_1 = 0·065 molar and k = 2·80 molar.

The fact that k_1 is so much smaller than k can be explained if the higher complexes from $Bi_3O_2^{5+}$ onwards tend to form closed complexes such as

Bi—O—Bi
| |
Bi—O

which should be favoured by electrostatic attraction. In this way larger complexes can be formed, such as:

Bi—O—Bi—O—Bi
| | | | |
O—Bi—O—Bi—O
| | | | |
Bi—O—Bi—O—Bi

These can be regarded as crystallization nuclei of the tetragonal $(MeO)_n$ sheets found in the crystal structures of many bismuth oxyhalides[1,5] and also in bismuth oxycarbonate[3] (Fig. 2).

It is not claimed, of course, that our picture of the reaction is exact. For example, the assumption of a common k is rather crude, and we have neglected the aquo acidity (which may become important at lower

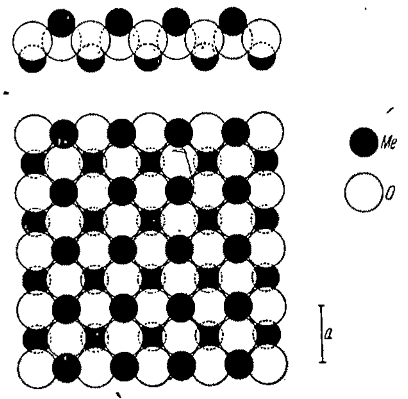
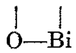
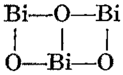


Fig. 2. TETRAGONAL METAL – OXYGEN SHEET IN BISMUTH OXYHALIDES, VIEWED ALONG *a* AND *c* AXES

(H^+) than those studied by us), and the possibility of rings of formula $(BiO)_n^{n+}$, such as  or  It is hoped, however, that our description records the essential features of the Bi^{3+} hydrolysis.

It seems possible that a similar mechanism (in some cases perhaps with OH bridges) occurs also in the hydrolysis of other ions, such as Sb^{3+}, Pb^{2+}, UO_2^{2+}, and may be Fe^{3+}.

A detailed paper on this work will be submitted to *Acta Chemica Scandinavica*.

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The Electron Affinity of ClO

IN a recent paper, Weiss[1] has given an estimate of the electron affinity of the ClO molecule, by a method which makes use of existing thermochemical data on the chlorine oxides and oxyacids. A necessary datum in the scheme of Weiss is the dissociation-energy of ClO, for which he chooses a value of 30·4 kcal. mol.$^{-1}$, quoting an early paper of Goodeve and Wallace[2]. Weiss appears to have overlooked a more recent publication by Goodeve and Marsh[3], in which the authors deduce that the ClO dissociation-energy is about 67 kcal. mol.$^{-1}$.

The latter figure is certainly more compatible with present views on the nature of the chemical binding in the ClO molecule. The resonance between the extreme structures:

$$:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{O}}}: \qquad \text{and} \qquad :\underset{\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}^+}}:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{O}^-}}:$$

(1) (2)

must result in a ground state of *greater* binding-energy than that of the normal electron-pair Cl—O bond. The normal Cl—O bond has an energy value lying approximately midway between the Cl—Cl and O—O bond-energies. Although there is some doubt in regard to the value of the O—O bond-energy[4], there is little question that the correct value is not *less* than Pauling's estimate of 36 kcal.; accordingly, the covalent Cl—O bond-energy may be estimated at not less than 47 kcal. The bond-energy in the actual ClO molecule must therefore be in excess of 47 kcal., by an amount equal to the resonance-energy of the interaction between the structures (1) and (2).

If the value (67 kcal.) given by Goodeve and Marsh is accepted as the best at present available, it may be combined with the value for the heat of formation of HClO aq. (26 kcal.) to give:

$$S(\mathrm{H}^+) + S(\mathrm{ClO}^-) + E(\mathrm{ClO}) = 416{\cdot}3 \text{ kcal.}, \qquad (1)$$

where the S terms are heats of solution, and the E terms are electron affinities. A further equation,

$$S(\mathrm{H}^+) + S(\mathrm{OH}^-) + E(\mathrm{OH}) = 427{\cdot}8 \text{ kcal.}, \qquad (2)$$

may readily be obtained from a knowledge of the heat of electrolytic dissociation of water, and the energy of rupture of the first OH bond in $H_2O(g)$[5]. Combining equations (1) and (2), it follows that

$$S(\mathrm{O\bar{H}}) + E(\mathrm{OH}) = S(\mathrm{ClO}^-) + E(\mathrm{OCl}) + 11{\cdot}5 \text{ kcal.} \qquad (3)$$

The heat of solution of the $\mathrm{Cl\bar{O}}$ ion is a matter for speculation, but it must certainly be less than $S(\mathrm{O\bar{H}})$; as a crude approximation, one might assume $S(\mathrm{\bar{O}Cl}) \sim 3/4\ S(\mathrm{\bar{O}H})$, on the grounds that the chlorine atom in $\mathrm{O^-Cl}$ virtually blocks one of the four positions in which water molecules normally surround the O^- or $\mathrm{\bar{O}H}$ ion. With this simplification, equation (3) becomes

$$E(\mathrm{OCl}) \sim E(\mathrm{OH}) + 1/4S(\mathrm{\bar{O}H}) - 11{\cdot}5. \qquad (4)$$

Bernal and Fowler[6] have estimated $S(\mathrm{\bar{O}H})$ at 105 kcal., and quote 276 kcal. for the term $S(\mathrm{H}^+)$: substitution of these figures in equations (2) and (4) gives

$$E(\mathrm{OH}) \sim 47 \text{ kcal.}; \quad E(\mathrm{OCl}) \sim 61 \text{ kcal.}$$

These values may be justified by an argument which is independent of assumptions regarding the probable values of the solution heats of ions. Representing the dissociation energies of the two processes

$$\text{(i)}\quad \mathrm{ClO} \rightarrow \mathrm{Cl} + \mathrm{O} - D_1$$

$$\text{(ii)}\quad \mathrm{Cl\bar{O}} \rightarrow \mathrm{Cl} + \mathrm{O}^- - D_2$$

by D_1 and D_2, and the electron affinity of the oxygen atom by $E(\mathrm{O})$

$$\text{(iii)}\quad \mathrm{O} + e \rightarrow \mathrm{O}^- + E(\mathrm{O}),$$

the electron affinity of ClO may be written as:

$$E(\mathrm{OCl}) = E(\mathrm{O}) + D_2 - D_1. \qquad (5)$$

Whereas the value D_1 is larger than the covalent Cl—O bond-energy, for reasons already discussed, it is probable that the bond-energy D_2 is almost identical with the normal Cl—O bond-energy. Resonance in the $\mathrm{Cl\bar{O}}$ ion is restricted to that between the covalent-bond structure $:\underset{\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}:\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{O}^-}}:$, and the ionic structure $\overset{+}{\mathrm{Cl}}\ \overset{=}{\mathrm{O}}$, and good reasons can be given for the expectation that the ionic-covalent resonance energy in this case should be small. Hence, we would expect $D_1 > D_2$, and $E(\mathrm{OCl}) < E(\mathrm{O})$. Vier and Mayer[7] have recently measured $E(\mathrm{O})$ as 71 kcal.; we have pointed out that the value D_1 is greater than the normal Cl—O bond-energy by not more than 20 kcal. Thus, we would conclude that $E(\mathrm{OCl})$ must lie between the limits 51 and 71 kcal.

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[3] Goodeve and Marsh, *J. Chem. Soc.*, 1332 (1939).

[4] See, for example, Skinner, *Trans. Farad. Soc.*, **41**, 645 (1945).

[5] See, for example, Weiss, *Trans. Farad. Soc.*, **31**, 966 (1935). Dwyer and Oldenberg, *J. Chem. Phys.*, **12**, 351 (1944).

[6] Bernal and Fowler, *J. Chem. Phys.*, **1**, 515 (1933).

[7] Vier and Mayer, *J. Chem. Phys.*, **12**. 28 (1944).

DR. SKINNER was good enough to send me a copy of his communication. More recently we have also been led to assume considerably lower values for the sum of electron affinity and heat of hydration of the ClO radical from a study of the photochemistry of hypochlorites in solution. This seems to suggest a value of $\{E(\mathrm{ClO}) + S(\mathrm{ClO}^-)\} \sim 105$ kcal.

I was, however, unaware of the ClO bond-energy value as given by Goodeve and Marsh to which Dr. Skinner has directed my attention.

Introducing this value into my previous calculations, the corresponding former figures should be diminished by the difference between the values of Goodeve and Marsh, and Goodeve and Wallace ($\sim$ 37 kcal.).

Thus one obtains $\{E(\mathrm{ClO}) + S(\mathrm{ClO}^-)\} \sim 128$ kcal. which, with the previously assumed value of $S(\mathrm{ClO}^-) \sim 60$ kcal., leads to $E(\mathrm{ClO}) \sim 68$ kcal.

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Physiological Heterogeneity of Metaphosphate in Yeast

IT has been shown that when yeast is fractionated by repeated extractions with cold trichloracetic acid a species of phosphate, found in both the acid-soluble and the residue fractions, is identifiable as metaphosphate[1,2]. The co-existence in a yeast cell of metaphosphate in both acid-soluble and acid-insoluble forms suggests the possibility that these two may differ in their metabolic and physiological function. It is the purpose of the present note to report some recent observations which indicate that this is the case.

Resting cells (*S. cerevisiæ*, baking type, 48-hour culture) were incubated under anaerobic conditions while suspended in a medium containing 6 per cent glucose, phosphate buffer (*p*H 4·5) and P^{32} labelled inorganic phosphate. After 2 hours incubation at 30° C., these cells were extracted with 5 per cent trichloracetic acid for one and a half hours at 3° C. The resulting supernate (S_1) was treated according to the flow sheet, Fig. 1. In the precipitation with the magnesia mixture the test solutions were allowed to stand overnight in the cold. The precipitate denoted as P_3 contained a portion of the acid-soluble metaphosphate and exhibited no activity, showing that no exchange had taken place. The orthophosphate contained in the supernate (S_3) showed that exchange had occurred to the extent of 24 per cent (based on initial P^{32} content of the phosphate in the medium).

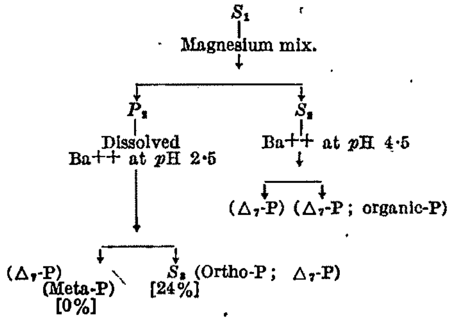

Fig. 1. Fractionation of the supernate from a cold trichloracetic acid extraction of yeast. The first step accomplishes a partial separation of metaphosphate by the use of a magnesia mixture which precipitates a mixture of meta- and orthophosphates. The metaphosphate can then be removed in a highly purified state by a precipitation with Ba++ at acid *p*H. As is indicated, the procedure does not remove all the metaphosphate from the original trichloracetic acid extract. Data in parentheses indicate type of phosphate compound found. Numbers in brackets give extent of equilibration with external phosphate in medium.

If the Schmidt[3] method of fractionation is carried out following the cold trichloracetic acid extraction, there is obtained a residue (R_5) which can be shown to contain a large amount of 7-min. hydrolysable phosphate (completely hydrolysed to orthophosphate by treatment for seven minutes with 1 N hydrochloric acid at 100° C.). If this is treated according to the flow sheet in Fig. 2, another metaphosphate fraction (P_8 of Fig. 2) can be isolated. This metaphosphate is a highly active fraction and has, as indicated, exchanged to the extent of 24 per cent. In fact, this is the only fraction thus far examined which approaches in activity that of the internal orthophosphate of the cell.

It appears, therefore, that there are at least two different kinds of metaphosphate in yeast, differing radically in metabolic function. One, which is easily extractable by trichloracetic acid in the cold, presumably does not exchange with any other phosphate fraction in the cell. The other, which is apparently associated with a proteinaceous material, is one of the most highly active organic phosphates in the cell. This result is reminiscent of work reported many years ago by MacFarlane[4].

Aside from possible implication for the physiology of the yeast cell, the results reported here concern the validity of conclusions derivable from isotope

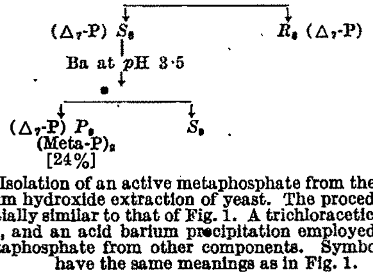

Fig. 2. Isolation of an active metaphosphate from the residue of a potassium hydroxide extraction of yeast. The procedure followed is essentially similar to that of Fig. 1. A trichloracetic acid extract is made, and an acid barium precipitation employed to separate the metaphosphate from other components. Symbols employed have the same meanings as in Fig. 1.

experiments. It is evident that the employment of chemical procedures which would recover all of the metaphosphate from the yeast cell as one fraction would mask the existence of physiologically different usages for the same chemical compound. Such a procedure could result in false conclusions with regard to the metabolic significance and function of such a compound.

Detailed accounts of the experiments described here will be published elsewhere. This work is being supported by a grant from the American Cancer Society.

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Maintenance of Spermatozoal Motility in Dilute Suspension

The rapid immobilization of mammalian spermatozoa which occurs when an ejaculate is diluted with a large volume of physiological saline is the basis of Milovanov's[1] test of 'resistance', used in assessing the value of a specimen for artificial insemination. Milovanov attributes this immobilization to the toxic action of chloride ions. Chang[2] also remarks on the low motility, rate of respiration and fertilizing capacity of rabbit spermatozoa in dilute suspension. Our own observations confirm these findings; rabbit spermatozoa at a concentration of 20 million/ml. in Baker's[3] solution remain motile for two or three days at room temperature, whereas at a concentration of 0·4 million/ml. they are motionless within an hour or two. In our experience this rapid loss of motility is not attributable to a toxic action of chlorides, since chloride-free diluents have an identical action.

Dr. A. Walton had told us of an observation in his laboratory that an emulsion of liquid paraffin helps to maintain the motility of suspensions of spermatozoa. His suspensions were not, however, highly diluted. Emulsions of liquid paraffin with a little gum arabic added to assist emulsification in Baker's solution were therefore tried, and found to be highly effective in maintaining good motility for short periods of time (not more than 6–12 hours). However, it was then discovered that gum arabic alone, starch, glycogen, egg yolk, egg white, crystalline serum proteins and a number of other substances are equally effective. On the other hand, agar, gelatin, sodium silicate and catalase are entirely without effect. Supernatants from other suspensions of rabbit spermatozoa proved highly effective, and the sperm-free plasma from a vasectomized buck was also effective, but not as good as supernatants from whole semen, prepared from suspensions which had stood overnight.

Full details of these tests will be published elsewhere, but the following table is included to illustrate the striking results obtained. The motility of suspensions kept at room temperature is given a score of between 0 and 4, according to the activity of the spermatozoa[4].

SUBSTANCES EFFECTIVE IN MAINTAINING THE MOTILITY OF SUSPENSIONS OF RABBIT SPERMATOZOA IN BAKER'S SOLUTION AT 4 × 10^5 cells/ml.

Substance	Ejaculate	Motility score at hour					
		½	1½	2½	4	6	24
Controls at 2 × 10^7/ml.	1	4	4	4	4	4	3
	2	3	2	2	2	2	1½
Controls at 4 × 10^5/ml.	1	0	0	—	—	—	—
	2	1	¼	0	0	—	—
0·25% W/V starch	1	3½	3½	3	3½	2½	0
	2	2	2¼	2¼	1½	½	0
0·25% W/V glycogen	1	3½	3½	3½	4	2¼	0
	2	3	2	2¼	2	1¼	0
0·25% carbohydrate-free serum protein	1	3½	3½	3½	4	3	½
	2	3	2¼	2¼	2¼	2¼	¼
0·25% serum protein containing 7% carbohydrate	1	2½	3½	3½	3½	2½	0
	2	3	2	2	2	2	0

Two features of this table need comment. First, there was sometimes a small rise in motility during the test, attributable to a rise in room temperature. Secondly, there was little or no motility in any but the control suspensions at 20 million/ml. at 24 hours, which demonstrates that the action of the various effective substances is not long maintained.

The capacity of such widely differing materials to preserve motility in dilute suspension makes it highly probable that their action is physical and not chemical. Therefore, the possibility was explored that they adsorb a toxic agent present in the diluent. Baker's solution contains traces of copper, lead and arsenic, and these seemed the most likely agents. However, neither special purification of the diluent nor the addition of relatively large excess of these metals affected the spermatozoa in suspension at 20 million/ml., which, surprisingly enough, are unaffected for the first six hours by 160 parts per million of copper or lead, or 48 parts per million of arsenic. Only copper eventually reduced motility, at 24 hours, in comparison with the controls. We were thus inclined towards a second hypothesis, that the various effective substances in some way prevent the escape of essential material, perhaps an enzyme, from the sperm cells. This receives support from the observation that repeated washing in Baker's solution does not cause immotility in suspensions at 20 million/ml. at a stage when the concentration of seminal plasma is reduced to that equivalent to dilution to 0·4 million/ml., but does cause immotility when further washings are given (controls washed repeatedly in the original supernatant, rich in seminal plasma, remain motile).

It is therefore concluded that the immobilizing effect of high dilution is probably due to the loss of vital material from the spermatozoa. The mode of action of the various effective substances which prevent the phenomenon is unknown. It seems unlikely, but possible, that they all contain some common impurity (like biotin) which is responsible for their effectiveness, and if so, it might operate in some manner other than the prevention of loss of intracellular material.

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Contribution of the Major Constituents to the Refractive Index of Milk

RECENT investigations[1,2] have shown the possibility of measuring the refraction in milk and the variations of the value under routine conditions of management.

A comparative examination of the refractive indices of more than 70 bi-weekly samples of milk and its rennet serum, prepared with one drop of Hansen's liquid rennet in 25 c.c. of milk, gave the following limits of variation of the constant. (In this proportion rennet caused no detectable addition to the refractive index of milk, as judged immediately after addition of rennet, and before coagulation set in.)

REFRACTIVE INDEX OF MILK AND MILK SERUM

Sample	Cow (R.I. 20° C.)	Buffalo (R.I. 20° C.)
Milk	1·3474–1·3506	1·3484–1·3534
Milk serum	433–447	436–453

These figures show not only that the elimination of casein reduces considerably the refractive index (fat having been shown to contribute nothing to this value[1]), but also that the variability of the constant of the serum is less than that of milk. Analysis of the entire data also showed that the refractive index of the serum does not always follow that of milk. This fact, and the lack of an exact linear relation between the refractive index and the solids-not-fat of milk[2], is perhaps caused by the differences in mutual proportions of the several constituents of milk. In other words, although two samples of milk (or of milk serum) may have the same solids-not-fat, the difference in the ratio of protein : lactose : minor constituents in the samples is responsible for the difference in refractive index.

Refractive index being a cumulative property, the presence of each solute adds to the refractive index of the water in milk. It has not been possible, so far, to determine the share of the several constituents in the total refraction, since there was no method of estimating the refractive index of milk. The method[1] recently devised enables such an estimation to be made.

A process of successive elimination of the major constituents and determination of the refractive index of the resulting fluids was used in determining the share of each. Casein (together with fat) was first eliminated with a drop of rennet. The lactalbumin and globulin in the rennet serum[3,4] was then removed by ultrafiltration with 'Cellophane' under a pressure of 20 kgm./cm.^{2}. The refractive index and composition (including lactose[5]) of the milk sample and filtrates were also estimated. The excess of the value of the refractive index of the ultrafiltrate over that of a solution containing the per cent lactose in the sample determined the share of the minor constituents (mineral salts, non-protein nitrogen, citric acid, etc.). From a number of samples of cow milk so examined the following conclusions have been drawn.

In the refractive index of milk, proteins contribute, next to water, the largest fraction, lactose ranks next and minor constituents the least. But *in proportion to their percentages*, water, proteins, minor constituents and sugar contribute in descending order. Among the proteins, considering their proportion, the lactalbumin and globulin contribute much more than casein. These experiments consistently gave a refraction of 0·0021 gm. casein in 100 c.c. of milk. This is slightly higher than the values given by Robertson[6] (0·00152) and Brereton and Sharp[7] (0·00181) for a 1 per cent solution of casein in 0·1 *N* sodium hydroxide. The higher value in the present series of experiments is perhaps to be attributed to difference in dispersion and composition in milk and in the sodium hydroxide solution.

The data also show that milk sugar contributes the most constant value to the refractive index, and confirms the inference from the table above that the wide changes in the refractive index of milk are accounted for largely by the variations in the protein content of milk.

Thanks are due to Mr. B. N. Banerjee and Prof. V. Subrahmanyan for their interest in these investigations.

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Aug. 1.

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Determination of Benzene Hexachloride in the Blood of Cattle

DE MEILLON[1] reported that various arthropods are killed when fed upon rabbits which had received 'Gammexane' by ingestion. Similarly, Dr. S. G. Wilson, of the Veterinary Research Laboratories, Entebbe, Uganda, has found that the blood of cattle which had received benzene hexachloride by oral ingestion was toxic to tsetse flies for a considerable time after treatment[2]. Although biological tests thus showed that the insecticide was circulating in the blood, it seemed useful to apply the normal methods for the analysis of benzene hexachloride to estimation of the concentration in the blood of treated animals.

The simplest estimation of this insecticide depends upon the removal of three atoms of chlorine from each molecule of any of the benzene hexachloride isomers by refluxing with ethanolic potassium hydroxide and afterwards titrating the chloride ions present in the solution.

Outline of the method: 10 ml. of fresh oxalated blood were ground with anhydrous sodium sulphate and extracted with benzene. After evaporation of the benzene, chloride formed by dehydrohalogenation of the residue was determined by one of two methods. Method 1 is the Volhard procedure as used by Neal *et al.*[3]. This was found to be too insensitive for the quantities normally recovered from blood, and Method 2 was substituted, in which the silver chloride was filtered off before titration with potassium thiocyanate solution. Recoveries of 'Gammexane' (the gamma isomer of benzene hexachloride), added to blood from untreated animals, were satisfactory, and the error does not appear to be greater than 2–3 per cent in the range of concentrations which have so far been found in cattle bloods. Details of the method will be published later.

Some results are given in Table 1.

One experiment has been performed in which a calf was sprayed with the insecticide in oil solution (an extract of crude benzene hexachloride with a mixture of equal parts by volume of power kerosene and cotton seed oil).

TABLE 1. BENZENE HEXACHLORIDE FOUND IN CATTLE BLOODS AFTER ORAL INGESTION

Animal	No. of doses (1 dose = 0·25 gm./kilo)	Days after ingestion	Mgm. found per 100 ml. blood	Method
5592	4*	7†	2·3	1
		14	1·7	1
		19	2·1	2
		29	2·1	2
5598	1	1	2·5	1
		2	1·5	1
		7	1·1	1
		14	0·4	2
5606	1	1	1·7	1
		2	1·5	2
		3	1·1	2

* On four successive days. † Counted from the last of these days.

Although this work is of a preliminary nature, it does appear that the insecticide persists in the blood for some time after oral ingestion, the actual duration depending upon the size of the initial dose. In addition, there is some variation between individual animals. The method used does not, of course, show that the substance determined is benzene hexachloride as administered, but in conjunction with the biological results it would appear that this is so.

TABLE 2. BENZENE HEXACHLORIDE IN BLOOD AFTER SPRAYING THE SKIN

	Days after spraying							
	0*	1	2	3	4	5	6	7
Deposit on hide, mgm./sq. ft.	0	41	8	14	10	0	0	0
Concentration in blood, mgm./100 ml.	0	0	0·3	2·5	2·2	0·2	0	0

* Just prior to spraying.

By the spraying experiment, it is indicated that at least one cause of the loss of effectiveness of insecticides applied in oil solution to cattle is absorption of the oil through the skin. Thereafter the compound circulates for several days in the blood, as was found after oral ingestion.

I am indebted to Dr. Wilson for the use of some of his experimental animals in these determinations.

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'DD' as a Means of Controlling *Heterodera rostochiensis* (Woll.)

INVESTIGATIONS during the past four years into the chemical control of *H. rostochiensis* have revealed that chloropicrin, ethylene dibromide, 'Dowfume G', 1–2 dichloropropene and 1–3 dichloropropane (crude 'DD') and two high boiling-point fractions of crude 'DD' are all effective soil fumigants. Because of its efficacy, ease in handling and comparative low cost, crude 'DD' is outstanding among these.

Concentrations up to 75 gallons of 'DD' per acre have been used with varying degrees of success. Soils ranging from almost pure sand to black fen (a deep, non-acid peat soil) were used; to effect a comparative kill a higher concentration was required in the latter than in the former. When 'DD' was injected at the 9-in. level, a 95 per cent reduction in plant infection has been achieved under field conditions in sandy soils. Recent laboratory experiments have shown that better results may be achieved when injection takes place at the 3-in. level. Experiments involving the use of soil 'seals' have resulted in a 99 per cent reduction in plant infection.

The treated areas should be left undisturbed for a considerable period; also a full crop rotation should intervene before host crops are again exposed to attack. 'DD' has marked phytocidal effects, and seed potatoes have been killed when planted within seven days of soil treatment.

'DD' has been effective at a wide range of temperatures (33°–75° F.) and also in soils which have been air-dried or contain up to 40 per cent moisture by weight.

Slightly more ethylene dibromide than 'DD' was necessary to produce a comparative kill. The effectiveness of 'Dowfume G' is considered to be due to the methyl bromide present.

Weed control was also obtained by the use of 'DD' both in England and Southern Rhodesia. In England the plants controlled were all perennials with an existing root system at the time of soil treatment. Control was only obtained on land in Rhodesia which was treated and 'sealed', resulting in one instance in a 100 per cent control of ropoko grass (*Eleusine indica*, Gaertn.).

'DD' kills a number of soil pests, including wireworms, cutworms and centipedes. Although it is cheaper than all the other fumigants tested, the quantities required to obtain control of potato eelworm are such that the cost of treatment is still too high for economic use in England.

We would like to record the discovery of viable cysts of *Heterodera rostochiensis* adherent to soil on seed potatoes imported into Southern Rhodesia from Scotland. From two fields in Lincolnshire on which potatoes had not figured in the crop rotations for eleven years, small numbers of living larvæ were recovered from cysts of *Heterodera rostochiensis*.

A full account of this work will appear in the near future.

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What is a Dialysate?

THE meaning of the word 'dialysate' as defined in the Oxford Dictionary is indeed apt to induce mental confusion. It did so recently in my own mind, when I had to struggle through an American patent specification, in which the term was actually used in its Oxford Dictionary sense. In my opinion, as well as in that of my collaborators, Dr. Pirie is quite right, and his discussion[1] supports our decision to use the term 'dialysate' for the part which dialyses through the membrane.

With regard to the part of the system retained by the membrane, Dr. Pirie agrees that the term 'colloid' is unfortunate; this is so because that part need not be a colloid at all. Might I propose the use of the widespread and comprehensive word 'residue'? This term does not admit of any ambiguity, and applies equally well to the processes of distillation, sublimation and even to that of filtration.

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[1] *Nature*, 160, 198 (1947).

SCIENCE AND TECHNICAL EDUCATION IN GERMANY

International Congress for Technical Education

AN international congress of especial interest and significance was held at Darmstadt during July 31–August 9, under the auspices of the Technische Hochschule and with the full and generous co-operation of the American Military Government. For the first time in many years a large gathering of men of science and educationists were able to meet in Germany in free and open concourse. In spite of the difficulties of travel, more than fifty foreign visitors were able to be present, in addition to nearly five hundred Germans who came from all parts of Germany, including a small number from the Russian Zone. Fifteen British representatives were present. It was an experience which was of absorbing interest, especially for the insight which it gave into the present mental attitude of the teachers of science in Germany and into the physical conditions under which they must now carry on their work. The latter is the easier to describe. The universities and *technische Hochschulen* have suffered very severe losses of buildings and scientific equipment by the War, text-books are almost unobtainable, the teaching staff has been drastically reduced and, moreover, many—especially in the American Zone—are still awaiting trial by denazification courts. Those who are left are struggling, with a spirit which is wholly admirable, to provide a higher education to as many as possible of the greatly swollen numbers of students.

As in Britain the War has interrupted the education of many young men and women, and the influx of these into the universities has strained beyond the breaking point the very small resources of German higher technical education. It was with this background that the Darmstadt Technische Hochschule, largely through the energy of its rector, Prof. Richard Vieweg, called together this congress of representatives of technical colleges and industry.

The programme was arranged to discuss four main themes: (1) technics as an ethical and cultural opportunity; (2) the present state and trends of development in technical education throughout the world; (3) the admission of students to universities as related to social problems; (4) the exchange of professional ideas. Perhaps the best way to describe the spirit in which this programme was tackled is to quote in full the very moving inaugural address given by Prof. W. Brecht: "Seen from a distance, every university gives the impression of being a well-balanced institution of strong intellectual life emanating from the university as a whole. But from close at hand you discover that the specific character of the college is due to the manifold subjects, characters, temperaments and peculiarities of the teachers and to the versatility resulting from all these many shades of differences. Thus a problem of great weight may remain unsolved for a long time owing to the tension of discrepancies, until all of a sudden you realize that somewhere else, nay, everywhere, the problem has grown beyond personal solution and must be turned over to universal handling.

"This is the first time that a Technische Hochschule has opened her doors and made an appeal to the world of science as a whole, in order to bring a problem of vital importance before a great intellectual tribunal. This attempt, as well as the nature of the problem, are born of the present time.

"The exterior of the Technische Hochschule has been destroyed. All that is left are a few disconnected, separate buildings in an ocean of ruins, the remains of a city that was fatally wounded by the war. But harder to bear than the difficulties of reconstruction is the utter loneliness of the present and the sorrow caused by the obscurity of events that still envelop her in a veil that makes her aims and desires invisible to those who are standing without. Though still lacking in strength, she has raised her voice, hoping that it will pierce the dark wall surrounding her. She is not calling for help. She is fully conscious of the heavy burden of the past, and has no other desire than to prove that she wishes to live in order to be able to do her part in the good work.

"Sometimes things only seem to be good. When we are striving so earnestly and decisively for purity of intent, the good sought for must be genuine. Thus the call of our Technische Hochschule is at the same time a summons to solve a vital problem. The problem in question is how to educate the youth of to-day that will in the future apply the findings of natural science so that applied science, this form of the human intellect, now expressed in superhuman dimensions, may not glide farther into those icy regions, where the emotions of the heart are eliminated. How can our students be led to employ science, this truly noble instrument, in a manner worthy of the dignity of the human race?

"There is no doubt that technical schools and high schools have succeeded in giving their students the benefit of excellent technical training. There are people who say the success was too complete. For technical inventions have changed our lives fundamentally even so far as to influence the spiritual lives. There have before now been men, who saw danger looming up in this unprecedented development, voices warning us because science and the scientific way of thinking had become too strong and too independent and had thus lost all ties that should have bound them to the common roots of culture.

"However, we do know that the technical mind in itself is not evil. It is clear and precise and here as nowhere else, every step of its evolution is dependent on uttermost purity. Therefore technical science in itself is not evil. Its absolute value is determined by its aim, and not by the direct aim, but by the final, deepest ends it is to serve. Therefore we must dig down to the roots and we must penetrate into the borderland in which originate the possibilities of good and evil. Greater knowledge as to the peril involved and the danger emanating therefrom should raise technical thought and technical work into an atmosphere impenetrable to contamination and suited to the true nature of science. And it is this purpose that the education of our students should try to serve. This is a great and difficult task and as yet there are to be found but the very faintest attempts at such education.

"But we hope that this meeting of men of science and learning may assist in clarifying our aims and finding the means of putting them into effect."

Papers by English authors which were read and discussed at the congress were: "Science as a Means of Christian Teaching", by A. Cameron, Cambridge; "Technical Education at Cambridge University", by D. B. Welbourn, Bedford; "Practical Training of Professional Engineers in England", by Sir Arthur P. M. Fleming and J. T. Kendall, Manchester; "Neuere Anweisungen und Formeln zur Bestimmung der zulässigen Belastung von Pfahlgründen", by C. Carty, London; "Engineering Education in England", by J. W. Bondi, London; "Remarks on Calculating Machines and Mathematical Tables", by L. J. Comrie, London.

Altogether some two hundred papers were read and discussed at the congress, some in the full session and some in the various sections. In addition, time was found for a large amount of informal discussion and lively argument. Nor was the social side forgotten; in addition to official receptions and informal *Bier Abende* there was an excursion to the lovely village of Lichtenberg on the Sunday, a performance of Bach's "Die Kunst der Fuge", and a performance of the new opera by Carl Orff, "Der Mond". This last is an artistic masterpiece, and was beautifully performed; but in its macabre and morbid outlook one seems to sense the subconscious hopelessness and tragic philosophy of the Germans to-day. This feeling of heroic tragedy has undoubtedly bitten deeply into the German soul; and after living for just a week in the ruins of Darmstadt and sharing, if only for a short time, in the present German way of life, one can realize how this must be. The congress was undoubtedly of inestimable value in helping to dispel a little of this gloom and uncertainty about the future, and its organisers were almost embarrassingly grateful for the presence and participation in the discussions of the foreign visitors. We, on our part, were equally grateful for having the opportunity to meet and talk with Germans who have miraculously kept safe, through the years of Nazism and the final ruin of their cities and intellectual life, a spark of intellectual freedom and probity and a capacity, one hopes, for rebuilding a new and more civilized Germany.

There is no space here to review the many papers presented at the congress and to record the discussions and the resolutions which were adopted. A full report of these will be published by the Technische Hochschule, Darmstadt. JAMES T. KENDALL

Berlin Technical University, 1947

THE Technische Hochschule in the Charlottenburg district of Berlin is one of the best-known institutions of its type in Germany and, like other universities in the British Zone, is now functioning as actively as circumstances permit, under the supervision of the Education Branch of the British Military Government. The following impressions are the result of a recent visit to the British sector of Berlin, during which the writer was engaged on lecturing to German students on behalf of the Control Commission for Germany. The observations are chiefly of a general character, but include a certain amount of detail appertaining to the writer's own field—physics.

During the War, the Technische Hochschule was extensively damaged and none of the main buildings remained entirely unscathed. The library was completely destroyed. In April 1946, when the surviving buildings were re-opened, the name was changed to Technische Universität. The main policy, formulated by the British authorities, is administered by a Control Commission liaison officer who deals with all matters concerning the Technical University and its relation to the broad educational system. The internal administration is carried out by a senate, which consists of fourteen members of the professorial staff, under the guidance of the Rektor, Dr. Walther Kucharski, who was appointed directly by the Control Commission.

At present the total number of students is 2,096 (1,850 men, 246 women), of whom 191 are non-German. There are the usual departments covering all branches of pure and applied science, and it is interesting that one of the most highly developed studies is architecture, which possesses a separate faculty and attracts large numbers of students of both sexes.

The students for the most part pursue their studies with an assiduity which is truly remarkable when considered against the forbidding background of German life. The gravity of the food situation has caused widespread 'black market' activity, and all sections of the population are compelled to participate to some extent if they wish to supplement their meagre rations. In addition to this problem (which confronts everyone), the students are handicapped by an acute shortage of text-books, note-books, stationery and similar material requirements. In spite of these adverse circumstances, great keenness is evident, coupled with receptiveness of mind and a mature, critical attitude towards educational matters. A marked sense of responsibility is noticeable at sessions of the Student Parliament, which has a fairly elaborate constitution and, as might be expected, is regarded as an essentially serious organisation. Invariably the attendance is large and the agenda lengthy, the various issues being debated in characteristically earnest fashion. There is, of course, the other side of the picture. The lighter side of student life is enjoyed with exuberance and vitality, a fact which is illustrated most effectively by the athletic meetings, where the considerable expenditure of energy appears to contravene any conservation principle!

So far as teaching is concerned, the main problems are inevitably those of accommodation and apparatus, and the experimental sciences, in which laboratory work is an essential part of the curriculum, are most seriously affected. Apart from bomb damage and the confiscation of all equipment connected with prohibited research, there have been heavy losses due to looting. In the huge main lecture theatre of the physics department, all the rows of seats and the electrical fittings were removed bodily. Owing to the scarcity of apparatus, there are virtually no laboratory facilities for advanced students, and overcrowding is unavoidable in the few laboratories which are in use. In the chemistry department, added difficulties are caused by the absence of fume cupboards together with inadequate ventilation systems. In the physics department the first-year laboratories are reasonably well equipped with the familiar experiments in general physics, heat, electricity and optics; neat design and high-quality workmanship are apparent in many of the instruments, but it is significant that there are no stop-clocks. Each experiment requiring a time measurement is provided with a device incorporating a revolution counter and a tiny synchronous motor driven via a transformer from the A.C. mains supply. A serious hindrance to laboratory work is the activity of the ubiquitous pilferer. In a metre bridge set-up, for example, most of the components have substantial 'black-market' value, and unless precautions are taken to safeguard the apparatus there is a high probability that it will be found one morning in a somewhat despoiled state. Experience has similarly shown the extreme undesirability of leaving electric lamps in accessible positions.

Considerable progress has been made in building up the library again, but little can be done to improve the text-book situation. In the Western Zones of Germany there is no paper available for the printing of scientific books, although the position of journals is slightly better. The *Zeitschrift für Physik*, for example, has just reappeared under the editorship of von Laue. A few copies of British and American scientific periodicals have found their way into the library, but the impossibility of payment prevents a regular influx of foreign literature.

Similar conditions are encountered at the Heinrich Hertz Institut für Schwingungsforschung, which is associated with the Technical University by virtue of the fact that its director, Prof. G. Leithäuser, is a member of the staff, and of the senate, of the University. This Institute is concerned with the training of engineers in radio communications and allied fields, and possesses facilities for a small amount of research. All work is, of course, subject to the usual Military Government scrutiny, and no micro-wave equipment is allowed. Suitable apparatus for teaching purposes is in very short supply and the number of available experiments is thus severely limited; one class of twenty-four students is obliged to work in groups of six as there is sufficient apparatus for only four experiments. The main lines of research are: defects of mirror systems, the design of large horn loudspeakers for low-frequency reproduction and various radio circuit problems. A pulsed transmitter (wavelength range 30–100 metres) is being designed for ionospheric investigations.

So far as research in physics is concerned, facilities at the Technical University are practically non-existent, and of the three professors, C. Ramsauer, H. Kallmann and R. Frerichs, the two latter are supervising small groups working at the Kaiser Wilhelm Institut in Dahlem. This is situated in the American sector and therefore all projects are submitted to the American authorities for approval. Prof. Kallmann, in addition to theoretical work in wave mechanics, is working on the detection of α- and β-particles by a scintillation method, using organic fluorescent materials. The scintillations are recorded by a photo-tube and the responses are amplified and shown on a cathode-ray oscillograph. Prof. Frerichs is investigating the properties of cadmium sulphide photo-cells embodying photo-conducting strips about 1 cm. in length. Interesting results have been obtained with β- and γ-radiation, and further experiments are being carried out with X-rays.

As a concluding remark, it may perhaps be appropriate to mention one of the most notable features of academic life, namely, the universal eagerness for contact with the world outside Germany and in particular with Great Britain. There are many reasons why such schemes as student exchanges can take place on only a small scale at present; but a few students and lecturers from Germany have already visited Great Britain under the auspices of the International Student Service, and it is to be hoped that many other visits of this nature will be made possible in the future.

B. DONOVAN

German Physical Society in the British Zone

Autumn Conference

An autumn conference of the German Physical Society in the British Zone was held during September 5–7 in the University of Göttingen. This conference gave striking evidence of German recuperative powers under considerable material difficulties, for it was attended by some five hundred physicists, and a formidable total of fifty-eight original papers was read. The conference was declared open by the president, Max v. Laue, and at this opening session the assembled members and visitors were greeted by Dr. R. Fraser on behalf of the Research Branch of the C.C.G. Although technically a British Zonal conference, in effect it was to some extent a meeting of the Physical Society for the whole of Germany, since delegates were also present from the French, Russian and American Zones. The younger generation was strongly represented and actively contributed, a fact calling forth the approval of many of the older German physicists. There is no doubt that organised physics in Germany has now recovered from the stagnant aftermath which followed defeat, and active research is being prosecuted from many centres.

Considerable satisfaction was expressed by many Germans present at the fact that a number of invited guests had arrived from abroad to read papers. These were: A. Michels (Amsterdam), V. L. Jordan (Copenhagen), B. Pippard, E. H. Sondheimer, D. Shoenberg (Cambridge), S. Tolansky (London), J. G. Wilson (Manchester), and all were received with warmth and given a particularly attentive hearing. The number of papers read was sufficiently large to enable the emerging pattern of interests in the post-war physics of Germany to be appreciated. Nuclear physics (in the wide sense) accounted for fifteen contributions divided into cosmic rays (5), nuclear reactions (5) and isotopes (5). There were nine papers on optics and spectroscopy, nine on metallic conduction and magnetism, and nine on acoustics. The remaining sixteen papers ranged widely, from quantum mechanics to diffusion pumps.

It will be gathered from this distribution that the pattern of interests is little different from what might have been expected from any German conference of pre-war days, and indeed the traditional emphasis so characteristic of Germany is well reflected. A matter of some considerable interest is the emergence of quite a number of unfamiliar place names as the centres of research. This may possibly be associated with war-time evacuation measures carried out to avoid the intensive bombing attacks, or perhaps for other reasons. In addition to many contributions from old-established and well-known university centres, papers were read about researches which had been carried out in such unfamiliar places as, for example, Hechingen, Weissenau, Tailfingen, Honnef, Horb, Markenkirchen, etc. It is stressed that these contributions were largely of the academic type normally expected from universities or associated establishments.

On each of the three days of the conference, a general review of a specific topic was given; these aroused a good deal of interest. The first, which constituted the opening paper of the conference, was delivered by W. Heisenberg. It was a clear and concise factual statement of the present position in cosmic ray research, and was a valuable and comprehensive contribution. The second general review was by K. Wirtz. The author was a member of a research team engaged on the German uranium project, and in his paper he surveyed the limited achievements of the Germans in this direction. The third general paper was delivered by E. Meyer, who surveyed recent developments in acoustics in a comprehensive manner.

In addition to the formal papers read, some specially arranged symposia were held, the visitors from Britain taking part respectively in those on metallic conduction and interferometry. The social programme was indifferent, which was inevitable in view of the difficult conditions in Germany to-day. In view of these quite serious difficulties, the conference must undoubtedly be considered as quite an administrative achievement and augurs well for the future of physical research in Germany, despite the very serious shortage in the current materials of research.

S. TOLANSKY

Statistical Methods

THE first meeting of mathematical statisticians ever held in Germany took place on September 3–4, 1947, in Göttingen. It was attended by British statisticians who had been invited in an endeavour to overcome the difficulties which German mathematicians have experienced by having been cut off from foreign literature for a long time. The losses suffered by libraries in Germany and the impossibility of replacing their stocks contribute to the desire of German scientific workers to resume personal relations with British (or other) contemporaries.

The first meeting was opened by Dr. H. Münzner, professor of theoretical statistics in the University of Göttingen. Prof. P. Riebesell (Hamburg) then gave a critical account of the methods of *Grosszahlforschung*, showing that this version of the statistical analysis of mass production is either trivial or false. He discussed the relation of the normal curve to empirical distributions and suggested a test of the significance of two or more observational modes based on the idea of confidence limits (*Mutungsbereich*). S. Vajda (London) gave a talk on "The Algebraic Basis of the Analysis of Variance Method" in which he derived well-known formulæ for the tests of effects and interactions of any order by the use of orthogonal polynomials, and pointed out how various possible but different definitions of effects were due to different algebraic constructions (see *Nature* July 5, p. 27.)

In the afternoon, Miss M. P. Geppert (Kerckhoff Institute, Bad Nauheim) proved by examples that in estimating a parameter from a sample none of the three central measures, mode, mean, or median, of the fiducial distribution needs coincide with the maximum likelihood estimate. Prof. O. N. Anderson (late of Sofia, now at the University of Munich) gave an account of the problems of inverse probability and fiducial limits, stressing the necessity for deriving formulæ pertinent to a model "without replacement"; he also discussed a formula which should take the place of the t-distribution in the case of relative frequencies (which are not normally distributed) for small n and $p \neq (1 - p)$.

On September 4, H. L. Seal (London) spoke on non-parametric tests and discussed some of them from the point of view of errors of the first and second kind. Prof. H. Münzner (Göttingen) introduced and solved an integro-difference equation which arises in the description of a 'cascade'-process where a particle multiplies k-fold, with probabilities dependent on k, at times t, the "intensity of multiplication" being dependent on t. Finally, Dr. E. Sperner (Oberwolfach) gave an account of his method of expanding meteorological functions in terms of eigenfunctions for the purpose of extrapolation.

An animated discussion took place in the afternoon at the Geophysical Institute, where the participants met by courtesy of the director, Prof. J. Bartels, whose notion of "persistence tendency" applied to time series (see *J. Amer. Stat. Assoc.*, June, 1940) gave rise to talks on a great variety of subjects, ranging from weather forecasts to the Heligoland explosion (see *Nature*, September 13, p. 350), seismic graphs of which were exhibited.

Many representatives of German statistics were, of course, unable to attend the meeting, but there was much interest in its proceedings. It was felt by all that the comparison of results obtained in ignorance of similar work done in other countries may prove stimulating, though at present Germany has scarcely anything to show which could compare with the fundamental progress achieved in Great Britain and the United States in the last twenty-five years or so. To facilitate the exchange of ideas it was decided to start work on an English–German dictionary of statistical terms, and to supplement it with proposals for a universal notation. Suggestions will be welcomed by Prof. H. Münzner (University of Göttingen, Germany, British Zone), or by the British visitors to the meeting.

S. VAJDA

Petroleum Geology

FOR the first time in the course of fifteen years, a meeting of those interested in oil geology was held in Hanover during September 9–11, about five hundred geologists and geophysicists being present. The State Secretaries of the administrative province, representatives of the Military Government, and numerous foreign guests were welcomed by Prof. Bentz, director of the Oil Department of the Reichsamt für Bodenforschung.

During the last fifteen years, several thousand wells have been drilled in north-western Germany, which have considerably increased the theoretical and practical information about the deep subsurface. The main part of the meeting consisted of reports from twenty-six German oil-fields. Their exploration by means of the most up-to-date methods has not only increased the production of the oil industry considerably but also provided much geological and geophysical material, which has helped to clarify the complicated tectonic, stratigraphic and facial conditions of the north-west German Saxonicum. Of the numerous Mesozoic rocks with oil-bearing possibilities from which the production of the north-west German oil-fields is derived, preference is still given to the Zechstein as the source rock of the oil; this hypothesis, however, was by no means placed in the foreground as the only one. The German oil industry owes its successes to this positive scientific attitude. It is only necessary to mention here the importance of the Ems district for German economic life. With regard to its reserves, this district is among the most important German oil provinces, and is thus also an important political factor.

Twenty oil-fields of north-western Germany are associated with salt domes, fifteen being of the flank type and five of the crestal type. Six fields are located on anticlines; for example, those of the Ems district. The source rocks are the main dolomite and the porous shale of the Middle Zechstein, the coral oolite of the Malm, the shell banks of the Wealden, the débris layers of the Neocomian, the chalk of the Upper Cretaceous, the sandstones of the Rhætic, the Lower Liassic, the Lower Dogger, Cornbrash, Valendis, and Lower Eocene. Almost all the fields are poor in gas content and subject to edge water drive. In 1946 the total production amounted to about 4,380,000 barrels.

In April 1947, geophysical results of a general interest were obtained from the blowing-up of the fortifications of the island of Heligoland (see *Nature*, September 13, p. 350). The depths of the North German area of sedimentation were established as approximately 3·1–6·2 miles, while the top of the sima near Göttingen was encountered at a depth of 17 miles, and at 25 miles at the edge of the Alps. The thickness of the continent, hitherto assumed as 37–62 miles, was thus considerably reduced; while fundamentally new knowledge of the major tectonic movements of the earth's crust was obtained.

Thirty-seven reports on the tectonics and palæography of Saxony, geophysical and petrographic methods of investigation, production engineering, and micro-palæontology afforded a comprehensive view of the state of German oil geology.

Many geologists were greatly stimulated by the meeting, and the synthesis between scientific research and its practical application was repeatedly emphasized. This synthesis alone has helped to achieve the results described during the meeting. A full report will be published in due course in the *Zeitschrift der Deutschen Geologischen Gesellschaft.*

An outcome of the meeting was the decision to found a Deutsche Gesellschaft für Mineralölwissenschaft and a Deutsche Geologische Gesellschaft for the British Zone.

W. Rühl

THERMIONIC EMISSION FROM OXIDE-COATED CATHODES

Oxide-coated cathodes have been used by the million for many years, but the explanation of the exact mechanism of the thermionic emission from them still presents many interesting physical problems. The summer meeting in London on June 14, arranged by the Electronics Group of the Institute of Physics, on recent work on such cathodes was most opportune, since the war-time use of the cathodes under pulse conditions, and the influence of recent theories of the properties of barrier-layer rectifiers and semiconductors, have stimulated further experimental and theoretical work, and are leading to a revision of views previously held.

Dr. F. A. Vick, of the University of Manchester, began the opening paper by summarizing the position in 1939. Activated cathodes were believed to consist of a mixture of barium and strontium oxides on a metal (normally a nickel alloy) core. Near the surface, strontium oxide was thought to predominate, and adsorbed on the surface a layer of barium, of concentration depending on the equilibrium between diffusion towards the surface and electrolytic movement towards the core during current flow. The high efficiency of oxide cathodes was supposed to be due to the lowering of the effective surface potential barrier by the adsorbed barium[1,2,3,4], analogous to the action of electro-positive layers on tungsten. Earlier workers had suggested[5,6] that the observed electron emission is determined by the potential barrier at the core-oxide interface, but by 1939 the role of the core had been relegated to assisting in the dissociation of oxides to provide some free barium.

The war-time use of oxide cathodes in valves used for pulse work directed attention to the fact that the peak saturated current in microsecond pulses could be many times (for example, 100) the normal saturated current at the same nominal temperature. Sproull[7] described careful experiments on the current-decay characteristics of the cathodes, with anode voltages kept constant for times varying between 100 and 2,000 microsec. and then switched off for times long enough for the cathode to recover. The saturation current rose to an initial high value and then decayed to an asymptote one-fifth to one-fifteenth of the initial value. Sproull suggested that as soon as the thermionic current starts to flow through the oxide, the concentration of the adsorbed barium layer commences to decrease from the equilibrium value under zero current to a new value depending on electrolytic movement through the oxide, and leading to a higher effective work function. Sproull inferred that electrolytic movement is easy through the oxide crystals but difficult across the crystal boundaries. Dr. Vick expressed the view that Sproull's theory is not the whole explanation of pulse effects, though some electrolytic movement of barium may be a contributory factor.

More recently, E. A. Coomes has published[8] an account of his work on the pulsed properties of oxide cathodes. He produced evidence to show that (i) a cathode giving good results under D.C. conditions is not necessarily a good pulse cathode, (ii) there may be a large temperature rise when heavy currents are drawn, (iii) a major limitation on the maximum pulse current is the onset of 'sparking' or 'flashing', (iv) the effect of the composition of the core metal on pulse properties may be considerable, pure nickel probably being the best. Coomes suggests a different reason for the enhanced emission, namely, that the electrons thermally excited into the conduction band of the oxide semi-conductor during the period between pulses are swept out during the pulse and added to the normal emission for a short period.

Dr. Vick went on to discuss work by Eisenstein and his colleagues on the use of X-rays to study the structure of oxide cathodes[9,10]. The results show, *inter alia*, that the crystal size of the oxide depends mainly on the maximum temperature reached during activation, that during life the composition of the surface layers becomes nearly pure strontium oxide (confirming previous results), and that special interface compounds are often formed at the core-oxide boundary, associated with an interface resistance *vs.* current characteristic similar to that exhibited by barrier-layer rectifiers. These and other considerations have led some workers to picture an oxide cathode as made up of the following sections: (*a*) metal core, (*b*) rectifying barrier layer, with direction of easy flow towards the core, (*c*) an excess semi-conductor with dispersed interstitial barium, (*d*) a region of strontium oxide with interstitial barium, (*e*) a surface potential barrier, the height of which may be influenced by an adsorbed barium layer. To determine the relative importance of the various factors and to fill in the details will require extensive work, both theoretical and experimental. Dr. Vick concluded the opening paper by outlining part of the programme of work recently commenced at the University of Manchester. C. A. Walley is applying the mass-spectrograph technique to identify the positive and negative ions emitted from oxide cathodes during activation and at all stages of life, and to correlate the ion currents with cathode structure and thermionic properties. W. Grattidge is studying methods of forming oxide cathodes without starting with the carbonates or using an organic binder, the aim being to obtain coatings with relatively simple and reproducible physical structures.

The next paper was contributed by Mr. D. A. Wright, of the Research Laboratories, General Electric Co. Ltd., Wembley, who dealt first with the factors affecting total coating resistance. He has applied the Mott[11] and Schottky[12] theories of barrier-layer rectification to the core-oxide interface. A potential barrier is to be expected at the interface, the difference between the work functions of the metal and of the oxide semi-conductor giving its height. The flow of electrons from core to oxide is then determined by barrier height, temperature, potential gradient through the barrier and the electron mobility in it. Mr. Wright's experiments using a magnesium–nickel core and a single probe embedded in the oxide have confirmed the existence of the barrier layer, with an effective resistance at low currents of 2–4 ohms per sq. cm., rising to tens of ohms at saturation. Hence at high currents the P.D. across the barrier layer can rise to some hundreds of volts, possibly leading to dielectric breakdown. The barrier layer may limit the emission available from the cathode, and its capacitance introduces a time-constant affecting changes in emission. Fineman and Eisenstein[10] have shown that the true coating resistance away from the barrier layer is of the order of 1 ohm per sq. cm. To lower the true coating resistance in the presence of a high-resistance barrier layer would give little overall gain in performance, but if the barrier layer resistance could be lowered at the same time, a considerable gain would be possible.

With a magnesium–nickel core, the height of the potential barrier at the core interface has been estimated to be about 0·7 eV. Mr. Wright's recent calculations show that the bottom of the conduction bands in BaO, SrO and CaO is not more than about 0·5 eV. below the zero-level. Conductivity measurements show that the impurity-levels of interstitial barium in barium oxide are between 1·0 and 1·5 eV. below the bottom of the conduction band. This gives a work function of 1·0–1·3 eV. Since this is of the same order as the observed work function for an oxide cathode, it indicates that any adsorbed barium on the surface has a small influence only on the work function. This is in agreement with the results of Nishibori and Kawamura[13]. In order to reconcile the value of the work function of the oxide with 4·6 eV. for nickel and the barrier height of 0·7 eV., it seems necessary to assume the presence of barium at the core-oxide interface.

Treating the observed emission as from an excess semi-conductor, assuming that the concentration of interstitial barium is 5×10^{17} atoms per c.c., the resistivity at 700° C. is calculated to be 300 ohm. cm., and the saturated emission 50 amp. per sq. cm., agreeing reasonably well with experiment. Methods of reducing effective resistance are being explored in the G.E.C. Research Laboratories.

Mr. Wright concluded his paper by suggesting a reason for the most effective cathodes being those with approximately equimolecular proportions of barium and strontium oxides. The reasoning is based on a minimum work function for interstitial barium in the surface layers of strontium oxide.

These two opening papers provoked a lively discussion which raised many points of detail for which there is no space in this brief summary. Mr. T. J. Jones (Admiralty Signals Establishment) directed attention to additional arguments in favour of an adsorbed barium layer being a predominant factor in controlling the effective thermionic emission. In one of his experiments[14] the outer layers only of an activated cathode were removed in a vacuum; this caused the emission to fall to about one thousandth. Subsequent operation at a suitable temperature restored the activity. Mr. Wright said that his own work and that of others had now stressed the importance of the core-oxide interface.

The last paper was contributed by Mr. A. J. H. Darlaston, of the Cosmos Manufacturing Co. Ltd., who gave a brief account of the preparation of oxide cathodes.

A fuller account of the proceedings at the meeting will be published in *The Journal of Scientific Instruments*. F. A. VICK

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TYPHUS RESEARCH

IN recent years research upon typhus has provided one of the best examples of the beneficent effects of international co-operation in scientific work. By agreement with workers in the United States and Canada, publication of many aspects of the work done on typhus at the National Institute for Medical Research, London, and at the Royal Army Medical College Emergency Vaccine Laboratory, Everleigh, Wilts, has been withheld. A full account of important parts of this work has now been issued*.

The researches of twelve workers are here recorded and Dr. C. H. Andrewes contributes a general introduction in which he explains that the report is not a comprehensive treatise on the clinical and pathological aspects of typhus, although it contains useful descriptions of these aspects of the disease, and especially of the Naples epidemic, which occurred between January and March, 1944, and is likely to have considerable historic interest. The report consists of five sections. Section 1 deals with the toxicity of two sulphonamides (*V* 147 and *V* 186), the highly promising activity of which against the murine type of typhus in mice had been studied earlier by Andrewes and his collaborators. Section 2 discusses in great detail the chemotherapeutic trials of these drugs in North Africa and at Naples, and the pathological studies associated with this part of the work. The two sulphonamides failed to fulfil the expectation raised by the earlier results obtained in mice, and the possible reasons for this failure are discussed. Section 3 describes a quantitative test for neutralizing antibodies against typhus Rickettsiæ. Section 4 discusses the comparison of four murine typhus vaccines in the laboratory and gives methods for the preparation of these vaccines. Section 5 compares the antigenic structure of a murine strain of typhus Rickettsiæ with that of a strain of epidemic typhus Rickettsiæ. The report concludes with two appendixes, one giving illustrative case reports and the other a list of drugs tested for chemotherapeutic activity against experimental typhus infection in mice.

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* Medical Research Council. Special Report Series, No. 255: Chemotherapeutic and Other Studies of Typhus. By M. van den Ende, C. H. Stuart-Harris, F. Fulton and J. S. F. Niven, with C. H. Andrewes, A. M. Begg, W. J. Elford, M. H. Gleeson White, W. L. Hawley, K. C. Mills, F. Hamilton and C. C. Thomas. Pp. ii+246+11 plates. (London: H.M. Stationery Office, 1946.) 12*s*. 6*d*. net.

It is impossible, of course, in a brief space to do more than indicate, as the preceding paragraph attempts to do, the solid value of every page of this report. It is an indispensable addition to the library of every worker on typhus and contains much that will interest the historian. Reading between the lines, one gets glimpses of Naples early in 1944, when the Italian civil authorities helped by their complete co-operation, although one of the immense difficulties encountered was the concealment of illness by the Italian community. The photograph published of an Italian deep underground air raid shelter, coupled with a little imagination and a dash of memory of Italy in happier days, makes it easy to visualize how a typhus epidemic can play havoc under the conditions then prevailing. The story of the dramatic effects of D.D.T. upon the lice vectors of the disease has been told elsewhere. Dr. C. H. Andrewes mentions that, when the method of intranasal inoculation of mice with material containing typhus Rickettsiæ was first used, all five of the workers using this method at Hampstead became infected, "fortunately with murine, not epidemic, typhus", and nine others working at Everleigh were also infected; but after the invention by van den Ende of a special inoculation box only one other worker was infected at Hampstead during the ensuing two and a half years, while none was infected at Everleigh. This gives an idea of the risks taken by these workers. Although there is still no specific drug which has a specific action on typhus Rickettsiæ, nobody will doubt that one will eventually be found. When it is found, it seems likely that the study of its use will provide valuable information about possible chemotherapeutic methods of attack upon other organisms which have so far resisted all drugs used against them. As this report says (p. 126), modern chemotherapy of bacterial diseases is supposed to depend largely upon interference with essential metabolic processes of the organisms, but a similar basis for attacks on the virus and Rickettsial diseases may be impossible, because these organisms depend upon "parasitism of the enzymes and essential metabolites of the host's cells". Perhaps future work, using this idea as a clue, will succeed in mastering these causes of this devastating disease.

G. LAPAGE

JAMES HUTTON: GEOLOGIST AND AGRICULTURIST

THE first ordinary meeting this session of the Royal Society of Edinburgh was held on November 3 and took the form of a commemoration of the hundred and fiftieth anniversary of the death of James Hutton [see also p. 694].

Sir Edward Bailey, who spoke on "James Hutton: Founder of Modern Geology: 1726–1797", devoted much of his address to Hutton's unpublished "Principles of Agriculture". He said that to anyone perusing Hutton's immortal "Theory of the Earth", it is clear he pictured his subject as a well-managed agricultural estate with a rotation of processes designed to maintain continuing fertility. One might therefore have expected to find in his agricultural treatise merely a disguised reproduction of his well-known geological tenets. Such is far from the case. Hutton, who spoke to geologists of æons, spoke to farmers of seasons and years. His object was "to make philosophers of husbandmen and husbandmen of philosophers".

The work, if published in its day, would rank among the classics. Its interest is comprehensive. For example, one sentence from a discussion of possible diversification of species by natural selection is remarkable: "Where dogs are to live by the swiftness of their feet and the sharpness of their sight, the form best adapted to that end will be the most certain of remaining, while those forms which are least adapted to this manner of chase will be the first to perish". It must be remembered that this was written by a man who died eleven years before Charles Darwin was born. Similarly, Hutton's account of selection of a pure line of rice, somewhere about the year 1710, by the Emperor Kang-hi, makes it difficult to realize that, when its author died, Patrick Shirreff, famous as pioneer-isolator of profitable strains of wheat and oats, was only six years old.

Hutton's writings on climate and chemistry, physics and metaphysics, are less valuable than his contributions to geology and agriculture; but through them all can be seen the working of a single great idea, a balance of the powers of Nature, which leads to never-ending cyclic continuity. If in one direction Hutton noted destruction, he always found in another direction proof of reconstruction. Thus, in geology, his unaided eyes told him how agents of erosion, under the influence of gravity, were slowly washing the continents down into the sea; while his reason assured him with equal certainty from available evidence that there was internal heat in the earth, which would presently re-elevate the consolidated debris high above the reach of the waves. Among Hutton's other famous contributions to geology may be mentioned the following: granite is an igneous rock, a claim based upon a number of veined contacts; geological processes of the past have been of the same kind and intensity as those of the present; the valley systems of the earth's surface have been sculptured by subaerial erosion operating through millions of years.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, November 24

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Industrial Applications of Inductor Alternators" (to be opened by Dr. J. H. Walker).

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Dr. Metcalfe Brown: "Smoke Abatement" (Clayton Memorial Lecture).*

Tuesday, November 25

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Colonel D. McMillan: "Hearing as an Essential Part of the Telephone Circuit".

Royal Anthropological Institute (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. W. L. H. Duckworth: "Some Complexities of Human Structure" (Huxley Memorial Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Development of Astronomical Instruments from Early to Modern Times". (Further lectures on December 2 and 9.)

Institution of Civil Engineers (joint meeting with the British Section of the Societe des Ingenieurs de France, at Great George Street, London, S.W.1), at 5.30 p.m.—M. A. Coyne: "Latest Developments of Dams and Hydro-electric Power Stations in France".

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Prof. H. Hartridge, F.R.S.: "Recent Advances in the Physiology of Vision".

Society of Public Analysts and other Analytical Chemists, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Third Annual General Meeting; Mr. B. S. Cooper: "Electron Microscopy".

British Esperantist Scientific Association (in the Department of Psychology, University College London, Gower Street, London, W.C.1), at 7 p.m.—Fourth General Meeting.

Society of Instrument Technology (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. D. Edmundson: "Electronic Developments in Instrumentation".

Wednesday, November 26

Physical Society, Optical Group (at Northampton Polytechnic, St. John Street, London, E.C.1), at 3 p.m.—Scientific Papers. (Members of the Colour Group are invited.)

Royal Microscopical Society, Technical Section (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mr. J. V. H. Wredden: "Microscopy of Enamelled Wire".

Society of Chemical Industry, Microbiological Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Papers on "Biological Stability of Processed Fish and Manufactured Fish Products".

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. E. W. Colbeck: "Some Metallurgical Problems in the Field of Atomic Energy".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Dr. F. P. Bowden: "The Initiation of Explosives"; Dr. W. A. Wooster: "Synthetic Mineralogy".

Thursday, November 27

Linnean Society of London (at the G.-B. Studios, Film House, Wardour Street, London, W.1), at 5 p.m.—Films.

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting; Prof. E. C. Titchmarsh, F.R.S.: "Analysis for Physicists" (Presidential Address).

Royal Institute of Chemistry, Manchester and District Section (in the Lecture Hall, Albert Hall, Peter Street, Manchester), at 7 p.m.—Dr. D. T. A. Townend: "Fuel and Chemistry" (Fourth Dalton Lecture).

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Symposium on "Pictorialism and the Characteristic Curve" (to be opened by Dr. S. O. Rawling and Mr. G. Scott-Bushe).

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the Public Library, William Street, Slough), at 7.15 p.m.—Dr. A. H. Lewis: "Some Aspects of Chemistry in relation to Agriculture".

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. P. Schulman: "Emulsions—Oil and Water Dispersal Mediums".

Friday, November 28

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Electrical and Magnetic Effects of Marine Currents".

Royal Institute of Chemistry, London and South-Eastern Counties Section (at Isleworth County School, Ridgeway Road, Isleworth), at 7 p.m.—Mr. J. King: "Scientific Problems in Feeding a Modern Army in the Field".

Society of Dyers and Colourists (at the Technical College, Bradford), at 7.15 p.m.—Mr. M. O'C. Horgan: "Infra-red Drying".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. F. Powell: "Tracks of Charged Particles in Photographic Emulsions".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Dairy Chemistry (Grade III), and an Assistant Lecturer in Agricultural Chemistry—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (November 28).

Lecturer in the School of Physics and Applied Science, to deal principally with telecommunications—The Registrar, College of Technology and Commerce, The Newarke, Leicester (November 29).

Lecturer (with qualifications and experience in mechanical or production engineering and, preferably, a university degree) in the Engineering Department of the County Technical College, Wednesbury—The Director of Education (Dept. F.E.), County Education Offices, Stafford (November 29).

Lecturer in Physics in the Department of Physics Applied to Medicine—The Secretary, Middlesex Hospital Medical School, London, W.1 (November 29).

Assistant in the Department of Natural History—The Secretary, The University, Aberdeen (November 30).

Lecturer (temporary) in Zoology at Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 1).

Lecturer in Applied Mathematics in the University of Cape Town—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 1).

Established Assistant Keeper (male) at the Botanic Gardens, Glasnevin, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 5).

Control Chemist and an Entomologist, a Senior Control Chemist and a Senior Entomologist, in a survey team investigating pest infestation in Nigeria—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (December 6).

Lecturer in Physics—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (December 6).

Lecturer in Social Psychology—The Registrar, The University, Leeds 2 (December 6).

Lecturer in the Department of Civil Engineering—The Registrar, The University, Sheffield (December 8).

Assistant Lecturer in Physics—The Secretary, University College London, Gower Street, London, W.C.1 (December 10).

Lecturer in Textile Engineering in the Department of Textile Industries—The Registrar, The University, Leeds (December 10).

Assistant Director in the Directorate of Telecommunications, and Divisional Telecommunications Officers (2), in the Northern and South-western Divisions—The Ministry of Civil Aviation, Establishment Division (B), 10 Fleet Street, London, E.C.4, quoting C.A.Est./1068 (December 11).

Research Assistant in Beekeeping—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow C.2 (December 12).

Professor of Applied Mathematics specialized in mathematical statistics or mathematical physics, in the Faculty of Science, Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens. London, W.1 (December 12).

Lecturer in the Department of Chemistry in the United College, St. Andrews—The Secretary, The University, St. Andrews (December 13).

Assistant Chemist in the Plant Protective Chemistry Section—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (December 15).

Demonstrator in Pharmacology—The Registrar, The University, Leeds 2 (December 15).

Director of Safety in Mines Research under the Ministry of Fuel and Power—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2044 (December 19).

Principal Scientific Officer, a Senior Scientific Officer, and Scientific or Experimental Officers (2), in the Department of Physiology—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (December 20).

Senior Principal Scientific Officer (Physicist) on the staff of the Joint Fire Research Organization of the Department of Scientific and Industrial Research and Fire Officers' Committee—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2050 (December 30).

Sir William H. Collins Professorship of Human and Comparative Pathology—The Secretary, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2 (December 31).

Professor and Head of the Physics Department of the Indian Institute of Science, Malleswaram, Bangalore—The High Commissioner for India, India House, Aldwych, London, W.C.2 (Bangalore, December 31).

Principal Scientific Officer or Senior Scientific Officer to investigate the chemical nature and fate during digestion of the different constituents of 'crude fibre' and of 'nitrogen-free extractives' of coarse fodders—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (January 1).

Director of Museums, Museums Department, Malaya—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Demonstrator in the Department of Bacteriology and Immunology—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Head of the Scientific Division—The Director of Research, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering, Northants.

Professor of Physiology—Rev. Father A. L. M. Danis, Faculty of Medicine, University of Ottawa, Ottawa, Canada.

Professor of Civil Engineering, and a Professor of Mechanical Engineering, at Maclagan Engineering College, Lahore—The High Commissioner for Pakistan, 15–16 Fitzhardinge Street, London, W.1.

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SCIENTIFIC ORGANISATION AND MANAGEMENT

IN a recent broadsheet, "Recruiting Civil Servants", Political and Economic Planning commented, as the Select Committee on National Expenditure has done, on the comparative weakness of the administrative class of the Civil Service on questions of organisation and management. The same question receives some attention in a report on the reform of the higher Civil Service prepared by a special committee of the Fabian Society; and the operation of the Division of Organisation and Methods in the Civil Service together with its effect on the staffing of Government Departments has been examined during the recent session by the Select Committee on Estimates. The fifth report of the latter Committee (H.M. Stationery Office, 1947. 4*s.* net) takes a fitting place with the sixteenth report of the Select Committee on National Expenditure for the session 1941–42, and indeed with the report of the Haldane Committee on the Machinery of Government; it merits close study at the present time in view of the bearing of this question on the most effective use of trained man-power.

From a wider point of view, however, these two recent reports are equally important. The report prepared for the Fabian Society reaches the general conclusion that since the Civil Service is now expected to provide for overall planning and the control and guidance of certain industries, the time has come to review and reform its methods of recruitment and training, its organisation and management. There are differences of opinion as to how far even a reformed Civil Service can be expected to be responsible for the conduct of industry, but there will be little dissent from the view that the new duties and responsibilities which it is legitimately and inevitably compelled to assume make imperative some fresh review of its structure, recruitment and training. That much is implied in the criticism of the Civil Service which is current; and a great merit of these reports is that they dispel much of the confusion and inaccuracy of such criticism and focus attention on the true defects, notably those arising out of its size and slowness, in a way that facilitates constructive proposals. Moreover, they bring into the open those other defects of the present organisation of government for the consequences of which the Civil Service itself has frequently been unjustly blamed.

The purpose of the Division of Organisation and Methods in the Civil Service is to secure maximum efficiency in the operation of the Government's executive machinery, and, by the expert application of scientific methods to organisation, to achieve economy in cost and labour. The Committee on Estimates quotes in its report from a striking speech of the Right Hon. R. C. Casey to the Institute of Industrial Management in Australia describing the results and methods of an organisation and methods investigation into the administration of Bengal. That investigation showed clearly and logically that the whole administrative machine in Bengal was fifty years out of date, and the Commission then recommended how it could be brought up to date. That quotation alone indicates some of the possibilities, and the Select Committee on Estimates, in reviewing the Home Civil Service, points out that in view of the shortage of man-power and the increased participation of the central Government in economic and social affairs, it is imperative that specialized attention should be given to the adjustment and re-designing of the machinery of administration. The ideas of organisation and methods are not, of course, new; some were propounded by the MacDonnell Commission in 1914 and elaborated by the Haldane Committee and the Tomlin Commission. Nevertheless, it remains for effective use to be made of the recommendations of these bodies and the instrument already provided.

Pointing out that up to now the engineering and analytical approach of 'Organisation and Methods' has only been used to introduce simplification at lower levels, the Committee observes that it is at the higher level of the Government machine that defects may occur which will react throughout the Civil Service and cause wasted effort at each executive level. These defects can only be satisfactorily remedied by measures applied at the source. Moreover when, as at present, the activities of Government are altering rapidly, the whole pattern of administration has to be adjusted to meet the new requirements, and a distribution of duties according to function has become essential.

Little, however, has yet been done to apply such reorganisation at the top level as between different departments. What is needed is not a sporadic shifting of duties which may well result in equally bad overlapping elsewhere, but some modification of the present pattern of the administrative machine. That is already foreshadowed in the setting up of a single Ministry of Defence to co-ordinate the activities of the three Service Departments, and still more recently in the appointment of Sir Stafford Cripps as Chancellor of the Exchequer and Minister for Economic Affairs, and the establishment of a new ministerial committee on economic planning over which the Prime Minister will preside. The Lord President of the Council, it will be remembered, already exercises a considerable co-ordinating influence over the country's scientific effort.

Clearly, as the Select Committee recognizes, issues of constitutional importance are here involved, such as the limitation of departmental autonomy. While such issues can be dealt with only at the highest level, the Committee considers that it is a matter of urgency that these questions should be attacked scientifically and not as a series of piecemeal adjustments made whenever the strain on different parts of administration becomes intolerable. In such re-designing, the Division of Organisation and Methods should be planning the structure and machinery of Government rather than attending to its plumbing and maintenance. The Committee welcomes, therefore, the assurance that the Division is now being reinforced with a small group of officers who have already had some years of experience in considering machinery of government questions at a high level. Still more, it welcomes the establishment of a small committee consisting chiefly of permanent secretaries, with the head of the Treasury as probable chairman, and it suggests that this committee might be actively concerned with these alterations in structure which affect the whole Civil Service, provided the committee meets regularly and is strengthened by experts on administration from outside the Service where necessary.

These, in fact, may well be the most important recommendations of this searching report. If industry is to be urged to become more efficient, the Government must put its own administration in order. Insufficient thought has been given to adapting the machinery of government to its new tasks, as *Planning* has repeatedly urged.

This is not the greatest danger. As the Select Committee notes, although some new ministries have been formed and much of the responsibility for the actual conduct of industrial and trading activities is being placed in the hands of quasi-Government boards, the size of the major Departments of State has of necessity much increased. The danger is that these may have become too large and cumbrous to work rapidly and efficiently as single administrative units. Redistribution of functions between existing departments might not, indeed, effect any striking economy in man-power; but a reconsideration of the whole pattern of the Government machine in the light of modern conditions might well suggest a reorganisation that would increase the rapidity and efficiency with which the ever-growing volume of work is discharged. Even if this did not reduce staff, it might obviate further increases and in that way prove true economy.

Nor is this all. A pattern has to be worked out by which the new national boards and other like public corporations which have responsibilities to the State can be incorporated in, or satisfactorily linked to, the administrative machine. Neither in man-power nor in finance can efficiency be secured unless the problem is viewed as a whole, and the task must be attempted by some body equipped for the purpose. The Civil Service has proved itself to be an adaptable organisation, and this valuable characteristic must be preserved in any new alignments.

A review at the highest level during the interval before the planned reviews by 'Organisation and Methods' staffs can be put in operation is suggested as advantageous by the Select Committee. It might well indicate the need for substantial readjustments, and these may affect organisation at lower levels. This is the real reason why the Select Committee is so firm in its view that there must be something much more than the extension of 'Organisation and Methods' work as seen in the past. There must be no more tinkering with the problem, but a thorough and careful scrutiny of the government machine as a task demanding the highest priority among the many demanding attention.

Strong support for this view is to be found in the report from the Fabian Society's Committee, in Mr L. S. Amery's recent book "Thoughts on the Constitution" and in a recent article by Lord Samuel

The latter, in suggesting a Cabinet of ten with a tentative grouping of departmental Ministers in five groups, urges that the time is ripe for a fundamental reform. Recent changes, he holds, have made little difference to the old system, and he suggests that by conferring wide powers on each of these groups, the chairman of each remaining responsible to the Cabinet for its proceedings, with the right to reserve for Cabinet decision matters of general concern or likely to give rise to controversy, or where there had been a serious difference of opinion, the groups might develop distinct individualities while preserving the elasticity which is so excellent a feature of the British constitution.

The Fabian Society's Committee covers a wider field, including within its survey besides questions of organisation those of Parliamentary and financial control as well as control of personnel, but is rarely so fundamental as the Select Committee. Its recommendations on 'Organisation and Methods' do not go much beyond the tinkering which the Select Committee deprecates. It suggests, for example, an Organisation and Methods Committee with qualifications to work out the best office procedure and with powers to impose it on all Departments, but it views organisation and efficiency here rather from the mechanical point of view. Even although it recognizes that the proper functioning of public boards controlling nationalized industries demands freedom and flexibility of action, and that control should not extend beyond matters of policy, it gives little clear guidance as to how such bodies are to be related effectively to the national administration. It recommends that public boards should be linked to the parent departments by small policy-forming bodies in the latter, while unnationalized industry should be guided by controls set up and disbanded as occasion requires on the lines of war-time experience.

While recognizing that for many problems, particularly short-term ones, inter-departmental committees provide the only means of handling problems affecting many departments, the Fabian Committee advocates the extension to the civil sphere of the Joint Staff Committee system, particularly in such fields as central economic planning, building and the supply of fuel and power. It visualizes a standing high-level committee of the permanent heads or appropriate senior officials of departments which are constantly engaged upon some joint activity, and under the general direction of a ministerial body, analogous to the Defence Committee. There should be in each department concerned a central planning organisation, and the Joint Staff Committee should consist of members of the departmental planning organisation, but detached for joint work, and the planning staff should be responsible both for making the plans and for seeing them executed. These planning staffs should be served by a central secretariat—part of the Cabinet secretariat—a vital responsibility of such a secretariat being interpretation.

The Fabian Society's Committee is under no illusions as to the effect of these recommendations in increasing the demand for senior Civil servants, and one of its recommendations is for the immediate admission to the administrative class of a further hundred recruits between the ages of thirty and forty-five. It is much less realistic than the Select Committee, or indeed than a group of Conservatives which put forward proposals for constitutional reform last year, in regard to what is possible with the limited resources of trained man-power in Britain.

There are sensible recommendations regarding leave, entertainment allowances, and amenities for senior officials, but the most interesting feature of this section of the report is the discussion of the relation of the administrative class to the professional, scientific and technical classes. It concludes that civil departments still too often ignore the help which scientific workers could give them on broad questions of policy as well as on technical matters, while the scientific specialists often make little effort to brief administrators properly on technical questions; there is the same lack of co-operation between the administrative class and the professionals. The two essential problems in developing satisfactory relations are to ensure that adequate use is made of specialists both in technical matters and in matters of broader policy, and in preventing the experts from seeing questions exclusively through technical spectacles.

Specific recommendations are on the familiar lines of transfer from the scientific and professional to the administrative class being facilitated, the improvement of pay and status of the former relative to latter, and encouraging mobility of scientific men and professional workers between the Civil Service and universities, industry and other outside employment. Beyond this it is suggested that departments should devise methods of keeping their scientific men and other professional workers informed, and consulting them at an early stage. It is also believed that there is scope for the new technique of operational research in civil departments, and that it could be used in public corporations to measure the value and efficiency of services to the public which can no longer be evaluated in terms of profits to the shareholders.

The Fabian Society's Committee is here on more debatable ground, and the issues are by no means clearly thought out; nor does the report show any clear conception of what is understood by operational research. Fundamentally, it is no more than scientific management properly understood, and from one point of view the use of the term 'research' is perhaps unfortunate and a misnomer. It is implicit in the suggestion, however, that the civil departments are not making sufficient use of the experts at their disposal; and as was brought out in the discussion at Dundee, notably in a contribution by Sir Robert Watson-Watt, operational research is here understood as a renewed attempt to solve the problem of the right relations of the administrator and the expert and the effective use of knowledge in the solution of social and economic problems.

Many of the suggestions put forward by Mr. Amery in his book referred to above are parallel with those made in the reports already noted. By reform and example at the top, he hopes to secure a real co-ordination of the work of departments in the light of coherent policies thought out beforehand, and to eliminate the extemporization and weak compromises which so often result from the attempt to reconcile conflicting departmental policies as and when a problem has obtruded itself on the attention of an overworked Cabinet. Incidentally, while Mr. Amery appreciates the need to encourage the creative and constructive side of the work of the Civil Service, he recognizes that departments have not been so lacking in initiative and creative thought as is sometimes suggested. He is severest on the Treasury, and insists particularly on the need for co-ordination here, as does the Fabian Society's report. That constructive criticism from such varied quarters should issue in such similar proposals should not be overlooked by those who, independent of party politics, are concerned to preserve our great heritage of freedom and adapt it to the needs of the present, having regard both to the new burdens and tasks of Government and to the dangers inherent in the neglect to keep the spirit rather than the letter of the constitution. It is to such criticism that we must look in approaching the general task of increasing the efficiency while decreasing the cost of government; by this means proposals for re-organisation may be forthcoming which will enable Government from the Cabinet downwards to cope effectively with the tasks which face it to-day.

PEOPLES OF THE INDIAN ARCHIPELAGO

The Peoples of Malaysia

By Fay-Cooper Cole. Pp. xiv+354+37 plates. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1945.) 22*s*. net.

PROF. COLE has aimed at giving, in a comparatively small volume, a conspectus of the extremely varied peoples of Malay affinities, at every stage of culture from that of the primitive food collector of Malayan jungles to the civilized inhabitant of Manilla or Batavia, who inhabit the Indian archipelago. The author postulates an underlying unity of culture multifariously and unevenly affected by various intrusive elements, and accounts for it convincingly by pointing out the way in which the courses of the great rivers of south-east Asia afford a number of extremely divergent outlets to the sea from the comparatively confined area of the sources of the Brahmaputra, Salween, Mekong and Yangtze. In the prolonged and diverse courses of their journeys to the islands, the various branches of the mongoloid stock from which the Malays spring have been subjected to very varied influences, and have received yet more and stronger ones after reaching their island homes. The great diversity that has resulted from this is illustrated by a series of accounts of different tribes chosen from various grades of culture and including tribes of Australoid and of negrito affinities which seem to have preceded the Malayan elements. These accounts are inevitably generalized, and are not all based on personal observation and knowledge, though the author's personal experience of the Indian Archipelago is obviously wide.

In such an account it is almost inevitable that there should be some inaccuracies and occasional dubieties, and while they detract little from the value of this admirable general account of the Malayan peoples, it is probably worth while directing attention to certain of them. Thus the author's general judgment on the problem of negrito variations is obviously sound, but he is very much out of date in putting the total of the Andamanese at 2,000. The number was a little less than that in 1901, and there were only 460 left in 1931. In the Census Report of 1941, the Andamanese do not seem to be mentioned at all. Prof. Cole suggests (p. 89) that the pygmies of Malaysia are unable to swim; but I have seen Andamanese swimming round and under a harpooned but very active dugong some 9 ft. long to rope its flukes to its sides by slipping nooses over its head. The Jakun are mentioned as using a blowgun "artificially bored as in Borneo". It should be made clear that they do not make it themselves; it has always been imported for them from Borneo.

Prof. Cole suggests that the Punans of central Borneo do not exist as a distinct people, but are merely parties of temporary nomads who have been mistaken for such. In view of the circumstantial and detailed accounts of Punans both by Haddon, and by Hose, who lived some twenty-five years in Sarawak, this suggestion seems almost frivolous, particularly in view of Prof. Cole's own statement as to want of knowledge of central Borneo. The suggestion (p. 211) that the long house is "a development from the widespread unit dwelling" may conceivably hold good for the Tinguian, but in many cases it is more likely that the development has been the other way, and that the long house has devolved into a narrow street of separate houses with the bachelors' communal house surviving as a separate building at one end. Indeed, intermediate stages in such a development have been observed in New Guinea.

The effect of contacts with Malaysia from India have perhaps not been entirely understood, for they must have started at a considerably earlier date than the development of Brahmanism; and on the other hand, there are indications of some very early development and dispersion of culture from a centre in the archipelago which possibly carried items of culture like househorns of the Menangkabau far afield to Assam and Madagascar. The ancient bronze 'kettledrums' of the Karens, of Siam, and of Cochin China have likewise been ascribed by some authorities to an island source, such as may have also been responsible for the great monolithic burial urns of Cochin China, Sumatra and Assam. Had the author cast his net wider than Malaysia, he would have found an even closer correspondence of cultural features widely spread in south-east Asia (and beyond it) than he himself suggests.

It remains to add that Prof. Cole criticizes severely the nature and effects of British Colonial policy in Malaya, contrasting it, much to its disadvantage, with the policy of American administrators and Roman Catholic missionaries. It would, we think, be possible to present a very different picture of the results of American policy in the Philippines without any greater departure from objectivity. There are several misprints, and the illustrations are poorer than we have learned to expect from American publications of this class.

J. H. HUTTON

SCIENCE AND PEACE

Science, Liberty and Peace

By Aldous Huxley. Pp. 64. (London: Chatto and Windus, 1947.) 3*s*. 6*d*. net.

WITHIN the limits of the present slender volume it would be manifestly absurd to expect a profound contribution to thought on the great issues named in its title. Nevertheless, while displaying once more the intellectual reaction against nineteenth-century faith in the capacity of science to improve human society which characterizes his philosophical writings, Mr. Huxley sets forth clearly the inter-relations between science, liberty and peace. The two essays of which the book consists make no claims to originality of thought, and it is easy to recognize the influence on Mr. Huxley's thinking of A. N. Whitehead, Louis Mumford, Karl Mannheim, E. H. Carr, Lord Lindsay and others. The slenderness of the volume should not, however, have prevented the inclusion of at least some references which would help the reader who is interested to explore further sources on which, consciously or subconsciously, Mr. Huxley has drawn.

Mr. Huxley concludes his book by commending Dr. Gene Weltfist's suggestion in the *Scientific Monthly* (September 1945) that technicians and men of science should take a professional oath similar to that of Hippocrates, pledging themselves to use their knowledge for the good of humanity and against the destructive forces of the world, and to work for such common ends with their fellow scientific workers of whatever nation, creed or colour, and he is presumably addressing himself primarily to the man of science and technician. It is not otherwise easy to discover either his purpose or the type of reader for whom the book is intended. For the general reader the argument is scarcely simplified enough. His main point regarding the small community, with the suggestion that science will assist us to solve the problem of power by devising methods to enable small communities to be self-sufficient in such matters as food supply and power, which is the essential contribution of the book, might well have been made clearer by using the Tennessee Valley Authority as illustration in greater detail. Had he done so he could scarcely have made the assumption that the 'integration' of a scientific and political approach involves the imposition of something from above and not the organic union and harmony of functions which McCurdy had in mind in discussing the problems of social organisation. Mr. Huxley criticizes rather obliquely the theme Col. Urwick developed in an address on "Compromise and Integration"; but it is difficult to believe that he has read either that or Lilienthal on the Tennessee Valley Authority.

Like so many others Mr. Huxley is better at diagnosis than prescription. He stresses rightly the immense power which science and technology have put into the hands of those who control the modern State, and he infers that if resistance is to be offered by the many to the few it must be in a field in which technological superiority does not count. But his defence of passive resistance is as naïve as his argument that it has never been tried is historically unsound. Again, while he recognizes the economic and social security which technological progress has brought, and although he pleads for the help of religion and for a moral basis for world order, he does not show the same awareness of the moral disintegration which Duckheim stressed or of the power of a moral tradition as the only effective brake on misgovernment.

These lapses and omissions detract from what is none the less an interesting and suggestive, if scarcely persuasive, book. Mr. Huxley, in truth, is too faint-hearted an advocate. He can see through many of the illusions of his time and, indeed, over-simplifies the issues. Even his argument for decentralization and development of the autonomous groups is advanced without much clear confidence that the man of science and technician will heed the summons to co-operate. Mr. Huxley sees clearly enough the implications for individual freedom of the concentration of power in ever fewer hands; but the argument for decentralization could have been strengthened had he analysed more fully or philosophically the idea of freedom. Recognizing that science and technology have changed the basic postulates of thought and that the scientific picture of the world is inadequate because science only deals with certain aspects of experience in certain contexts, he urges the study of philosophy by the man of science and technician, and that ministers of religion should teach a new doctrine of the Final End of Man rather more nebulous than that according to the Shorter Catechism.

If Mr. Huxley's remedies seem to be over-simple they are not necessarily invalid so far as they go, and this plea for a re-statement of the Emersonian doctrine of self-reliance with particular reference to the techniques available for achieving independence within a localized, co-operative community is pressed as the means of securing the abolition or elimination of war, in spite of the opposition from Governments which anything like a popular movement would encounter. Mr. Huxley suggests that as individuals or in organised groups scientific workers can help in three ways. First, and negatively, they should consider the problem of right livelihood in its relation to their own contemporary activities, and they should seek answers to these questions on the level of their international organisations. Next, he suggests tentatively the exploration in a wider field of the plans for an international inspectorate already outlined in regard to the atomic bomb and the pooling of all scientific discoveries considered by competent experts to be even potentially dangerous to mankind.

Scepticism as to the value of such safeguards will not be diminished either by the publication of the new Russian law classifying as State secrets research and experimental work in all branches of science and technology or by the exclusion of atomic energy from the discussions at the recent International Congress of Pure and Applied Chemistry. Mr. Huxley looks more hopefully to action initiated in the scientific field and ending in the political. The planning of scientific activity for predetermined political, social and economic ends must begin where the results of disinterested research—which itself cannot, he observes, be planned more than to the extent of subsidizing inquiry into neglected branches of knowledge—are applied to the solution of practical problems. Individually and through their professional organisations men of science and technicians could, he maintains, do much to direct planning towards humane and reasonable ends. Further, he thinks it possible, if not essential, for technicians and men of science to adopt a professional policy, consciously and deliberately designed to serve fundamental human needs and to forward the causes of peace and personal liberty.

That, indeed, might fairly be described as the purpose of the Atomic Scientists' Association; but Mr. Huxley insists that only an international organisation of men of science could work out such a policy in detail. Tentatively he indicates what such a policy would include: a world-wide campaign for greater food production, including regional self-sufficiency in food production, and, scarcely less important, self-sufficiency in power for industry, agriculture and transport. On the technical implications of such a policy he does not enlarge, although he notes that the storage as well as the production of power has to be considered, but expresses the opinion that atomic energy is, and for a long time is likely to remain, a source of industrial power that is politically and humanly speaking in the highest degree undesirable.

Mr. Huxley has ideas and suggestions that merit discussion, but whether this book of itself will stimulate such debate is doubtful. It lacks the conviction that compels to action. The critic who shatters illusions remains too much the sceptic to be the prophet or apostle of a crusade to overthrow the tyranny of which he complains and build a new world in which science will be free and used for peace.

R. BRIGHTMAN

PALÆOBOTANY FOR EVERYMAN

Ancient Plants and the World they Lived In

By Assoc. Prof. Henry N. Andrews, Jr. Pp. ix+279. (Ithaca, N.Y.: Comstock Publishing Co., Inc.; London: Constable and Co., Ltd., 1947.) 25*s*. net.

THIS book is an attempt, and a very successful attempt, to convey to the general reader an idea of the vegetation of the earth in ages long past and the indications it may give of the climates of those times. From a study of their fossil remains so many details are now known about extinct plants that it is no easy task to give a convincing description of what the vegetation was like without becoming involved in highly technical descriptions of many individual plants. The author has shown admirable discrimination in his choice of examples, and gives a clear picture of the kinds of plants which dominated the vegetation at different periods in the past. He has skilfully steered a compromise course between the Scylla of technical jargon and the Charybdis of terminological inexactitude, and the book is written in a very readable and racy style.

The author is evidently an enthusiastic collector of fossil plants and will certainly stimulate others to take an interest in them. The study of fossil plants, palæobotany, has been greatly neglected in most countries, and in very few schools of geology is any instruction in palæobotany given. Such a book as this will help to show the geologist in how many different directions the study of plant fossils leads to a widening of our knowledge of the past history and climate of the earth.

The book is admirably printed and illustrated. One very impressive illustration is of an open-cast working at Wyodak, in Wyoming, in which there is a 90-ft. seam of coal. Other illustrations include excellent views of the Yorkshire coast and other places in Britain and North America which are notable for the fossil plants which have been found there. The author gives a clear idea of the appearance and nature of fossil plants and where they may be discovered. He explains the manner in which coal has formed and some of the methods used in investigating its structure. For those who have had no botanical education he provides a useful little appendix on the structure of living plants.

The author in the next edition should provide fuller descriptions of the illustrations and make greater use of letters with guide lines. In some illustrations (for example, Fig. 100) there is nothing to indicate the positions of the parts mentioned in the description, and the non-specialist reader will be at a loss to understand what the figure represents.

JOHN WALTON

APPEAL OF MUSEUMS

Native Animals of New Zealand

(Auckland Museum Handbook of Zoology.) By A. W. B. Powell. Pp. 96. (Auckland: Auckland Institute and Museum, 1947.) N.p.

THE educational function of museums has been much discussed in Great Britain during the last decade but, with notable exceptions, the attractiveness of their exhibitions has not been great enough to draw in and hold many, apart from those who already have some interest in the museum contents. There are many reasons for this lack of appeal, one of them being lack of imagination on the part of museum authorities and a strange unfamiliarity with the methods by which the general public should be encouraged to compel its interest. For these and other reasons this book should be carefully studied by museum authorities; similar publications would do much to increase the attractiveness of their own institutions.

While the work primarily is meant to be a guide book to the New Zealand natural history exhibits in the Auckland Museum, the author has avoided the easy temptation of allowing it to become a mere catalogue. The book is, in fact, a popular treatise on the native fauna, providing simple descriptions, recognizable illustrations and brief but essential information concerning the better known and more interesting New Zealand animals. For ease of recognition the figures have been drawn from actual specimens and, in order to help the amateur naturalist in recognizing animals in their natural surroundings, the text is mainly concerned with external appearances, habitat and behaviour. In keeping with evolutionary theory the animals have been arranged approximately in their systematic order although, since the handbook is mainly concerned with sight identification, all microscopic animals are omitted.

A cursory glance at the 411 illustrations shows some of the peculiarities of the New Zealand fauna. The absence of land mammals is at once conspicuous, and the inquisitive reader finds a reason for this expressed in clear and interesting language. The comparatively large number of flightless birds is also readily apparent and is accompanied by a careful account of each species. Animals like the tuatara (*Sphenodon punctatus*) and *Peripatus* are given special mention, as are the remarkable summer migrations of birds like the godwit and cuckoos. Mr. Powell must be thanked for producing a work which will not only add to the attractiveness of his own museum but which should also put ideas into the heads of discriminating museum workers elsewhere.

T. H. HAWKINS

V. Rosický

By F. Slavík. Pp. 24. (Prague: Czech Academy of Science and Arts, 1946.) 12 crowns.

PROF. VOJTĚCH ROSICKÝ was a distinguished Czech mineralogist whose scientific work was cut short by his execution at Mauthausen concentration camp in February 1942, in his sixty-second year. His father, who died in 1919, had been a naturalist and writer on scientific subjects, and young Rosický grew up in an atmosphere of excursions to forest and mountains in search of specimens. He began as science master at a Prague *Gymnasium*, for which he wrote a "Chemie a Mineralogie". Later he went to Munich as Groth's assistant; eventually he returned to Prague and, in 1920, became professor of mineralogy at the new University of Brno. His publications—mostly in Czech although some appeared in the *Zeitschrift für Krystallographie* and in French journals—dealt with crystallographic methods, the physical properties and measurements of crystals and the relation between physical properties and water content. He described, often in great detail, a variety of minerals from Europe, South Africa and South America, including a joint work with V. M. Goldschmidt on a topaz from Minas Geraes. Rosický also made some petrographical studies and wrote several text-books, including a lengthy "Krystalografie", one volume of which appeared in 1929 (with more than five hundred illustrations). The second half he left in manuscript, which is now being prepared for publication by Dr. J. Sekanin, with whom he was conducting X-ray crystallographic researches until the University was closed in 1939.

Prof. Slavík, himself a mineralogist well known in Britain, has written this short biography in appreciation of his countryman's contributions to mineralogy.

J. G. F. D.

L'Organisme en lutte contre les microbes

Par André Boivin et Albert Delaunay. (L'Avenir de la science, 24). Pp. 425 + 15 plates. (Paris: Libr. Gallimard, 1947.) 320 francs.

THIS latest addition to Gallimard's popular science series is of the same high standard as its predecessors, some of which have already been reviewed in *Nature*. Without diminution of scientific value the subject has been reduced to terms which can be understood by non-medical readers, but the book would be useful and easy reading for medical students preparing for examination.

The first part describes bacteria and viruses and the nature and evolution of infectious diseases. The second part describes the body's defences against invading organisms; the role of the phagocytes, antigens and antibodies. Part three deals with prevention and treatment of infectious diseases. Recent advances in chemotherapy and antibiotics are included. There is a detailed list of contents, but, unfortunately, no proper index.

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1946. Edited by H. T. Montague Bell. Pp. xii + 504. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 42*s*. net.

THIS valuable volume makes its one hundred and eighty-eighth appearance as a full and objective record of the year's events. It is under new editorship, Dr. Epstein having died during the past year, but retains its well-established plan and scope. British history is told in four sections, followed by the history of the Commonwealth and Empire, with the troubled story of India and Burma. Then an equal share is devoted to foreign history, including the United Nations Organisation. Here the four Great Powers have the major part, but naturally the States of the troubled eastern side of Europe receive considerable attention. The latter part of the book is devoted to the usual chronicle of the year, obituaries and surveys of literature, art, science and finance. The public documents printed in full are the Anglo-Siamese agreement, the Yalta agreement and the White Paper on India.

Outlines of the Geography, Life and Customs of Newfoundland-Labrador (the Eastern Part of the Labrador Peninsula)

Based upon Observations made during the Finland-Labrador Expedition in 1937, and the Tanner Labrador Expedition in 1939, and upon Information available in the Literature and Cartography. By Prof. V. Tanner. Vol. 1. Pp. ii + 436. Vol. 2. Pp. ii + 437–909. (Cambridge: At the University Press, 1947.) 2 vols., 50*s*. net.

LABRADOR has a considerable literature of its own, as the full bibliography in this volume shows, but it is mainly concerned with the coastal regions which constituted that part of Labrador under the rule of Newfoundland. In 1927 the Privy Council brought within Newfoundland-Labrador the Atlantic drainage, leaving the remainder to Canada. Thus an area of about 100,000 square miles is a dependency of the former dominion of Newfoundland. The two large and beautifully illustrated volumes of this work, originally printed in Finland in *Acta Geographica*, do not claim to present a completely co-ordinated geography of Labrador. They contain rather the raw materials of such a work, from which much can be deduced. But the work is admittedly incomplete, partly because of the vastness of the area and partly because the second expedition of Prof. Tanner in 1939 was interrupted by the outbreak of war. It is, however, of interest to note that Prof. Tanner, versed in the conditions of Finland, sees no reason why much of Labrador should not eventually be colonized, even if it cannot become a self-supporting agricultural country.

I Know an Island

By R. M. Lockley. (Harrap's Country-Lovers Library.) Pp. 243. (London: George G. Harrap and Co., Ltd., 1947.) 8*s*. 6*d*. net.

ISLANDS where the sea-birds come to breed have a peculiar fascination, an appeal felt early and with great force by Mr. R. M. Lockley. He was not happy until he had acquired one, and even then he was not satisfied. Skokholm, that sanctuary of Manx shearwaters, storm petrels, puffins, etc., off the Pembrokeshire coast of Wales, only whetted his appetite for islands. In his book "I Know an Island", first published in 1938 and now reprinted, he tells of his own island of Skokholm, the neighbouring islands of Skomer, Grassholm and Ramsey and their inhabitants, both winged and furred, before going on to islands farther afield. The Blaskets off the Irish coast, Heligoland, Fair Isle, the Faeroes and the Westermann Islands are among those visited and interestingly described, with special reference to ornithological matters. For example, Mr. Lockley searched far for Leach's fork-tailed petrel, to find it at last on Sudurey in the Westmann Islands.

F. PITT

LOW-TEMPERATURE PHYSICS IN NORTH AMERICA

By Prof. J. F. ALLEN
University of St. Andrews

During the past summer, an opportunity was taken to visit the principal laboratories in the United States and Canada which are engaged in low-temperature research, with the exception of the Naval Research Laboratory in Washington, the laboratory directed by Giauque at Berkeley and that planned by Long at Chicago.

Prior to the War, comparatively little interest was shown in America in cryogenic research, with the notable exceptions of the Chemical Laboratory at Berkeley and the McLennan Laboratory at Toronto, and on the whole what interest there was lay in the field of chemical thermodynamics. To-day, although the position is changing rapidly, and again with the possible exception of Berkeley, there are still no cryogenic laboratories in America such as we know them on the eastern side of the Atlantic, equipped to carry out physical research in all the principal low-temperature fields, of which the three most important are superconductivity, paramagnetics and the properties of liquid helium. But the position is changing very rapidly indeed. There is in America a growing realization of the importance of low-temperature physics, and a very rapid growth in the number of laboratories using liquid helium. There are roughly a dozen such at the present time, and another dozen will probably be added within the next year.

This extremely rapid growth has been made possible largely by the new liquefier designed by Collins of the Massachusetts Institute of Technology. This liquefier can be considered as deriving from the one designed by Kapitza, but it is carried a stage further in that all the cooling is obtained by the principle of external work, and no other refrigerant, such as liquid air or hydrogen, is required. There are in the Collins machine two expansion cylinders and pistons, one operating at roughly the temperature of liquid air and the other at the temperature of liquid hydrogen. There is essentially only one heat exchanger, which is tapped off at two points to feed the cylinders, and at the bottom end is the Joule–Thomson valve where liquefaction is performed. The whole apparatus is extremely simple and elegant. It has been designed for something like mass production and can now be purchased, more or less 'over the counter', from the Arthur D. Little Corporation of Cambridge, Mass., for 18,000 dollars (August 1947 price). For this, it was learned, one obtains the complete plant, including gas holder, garage-type compressor, helium purifier and auxiliary vacuum pump, installed and ready to run. The whole assembly, less the gas holder and compressor, is fitted into a rectangular box about 5 ft. 6 in. in height, 3 ft. 6 in. wide and 3 ft. deep. The machine takes about four hours to cool to helium temperature and will then produce somewhat less than two litres of liquid helium an hour. It is not limited to helium production, but by its nature it will liquefy any gas. If, however, other liquid gases are wanted, it is possible to use helium as the working substance and liquefy other gases by contact, and it can thus provide a particularly useful and safe way of making liquid hydrogen.

The Collins liquefier, being compact, self-contained and simple to operate, is an admirable liquefier for the laboratory in which it is desired simply to extend existing researches or measurements to the helium range of temperatures. Also, it is designed expressly for the purpose of having experimental apparatus installed directly in the liquefier, since there is an opening in the top some 5 in. in diameter and a clear space beneath at least as large leading directly to the liquid helium bath. These reasons, together with the fact that the U.S. Navy makes extremely generous provisions for physical research in America, produce a tendency in the more ambitious laboratories to have a separate Collins machine for each experiment. Both the Naval Research Laboratory in Washington and the Massachusetts Institute of Technology have two liquefiers, and it was understood that both laboratories were planning to acquire additional ones.

It is, of course, easily possible to decant the liquid helium from the Collins machine; but that requires additional equipment such as Dewar vessels and liquid air for the thermal shielding, which are not always available. Hence the liquefier tends to be used for experiments which do not require either visual observation through the apparatus or the presence of magnetic fields. Furthermore, due to the comparatively poor shielding of the liquid in the liquefier from room-temperature radiation, it is not easy to reach a very low temperature by reducing the vapour pressure of the liquid.

Two other helium liquefiers which are being constructed are of interest. In Toronto an attempt is being made to use a turbine as a means of extracting work, and in the Ohio State University at Columbus a very large output of liquid helium is expected from a Joule–Thomson liquefier using only liquid hydrogen, of which there is a plentiful supply, as a refrigerant. A feature of the laboratory at Columbus was the immense size of the cryostats. The glass Dewar flasks, made on the premises, were four to five feet in height and six to eight inches in diameter.

Several other laboratories have small Linde or Simon single-expansion liquefiers, and at Yale there is a more or less exact replica of the Kapitza liquefier in the Royal Society Mond Laboratory at Cambridge.

Of the low-temperature research which is going on there is, of course, a considerable amount of accurate calorimetry devoted to chemical thermodynamics. On the physical side, the most important subjects at the moment are the separation and properties of the isotope helium 3, and the behaviour of superconductors under the action of very high-frequency currents, using radar techniques.

The phenomenon of the disturbance of superconductivity by high-frequency fields was first observed by H. London in Bristol before the War, and the effect of using 25-cm. waves in superconductors and in normal metals has been examined in detail by Pippard in Cambridge since the War. At the Massachusetts Institute of Technology, under Slater, and at the Naval Research Laboratory in Washington, the problem is under investigation using 1·25-cm. waves. The superconductors which have been investigated so far are tin and lead, and the methods which are employed are slightly different in the two laboratories. At the Massachusetts Institute of Technology, the waves, conducted in by wave-guide, are reflected at the end of the guide by a superconducting element which is in the form of a cavity of the dimensions of the guide, across which a thin perforated superconducting membrane is stretched. At the Naval Research Laboratory the waves are conducted down to a superconducting drum-shaped cavity and the energy absorption is measured by the determination of the ringing time of the cavity.

Slater has obtained results similar to those of Pippard, but the destruction of superconductivity was more complete, as was to be expected from the higher frequency which has been used. He is also studying the so-called anomalous skin resistance of normal metals at low temperatures.

The work on the properties of the rare isotope helium 3, which has a normal concentration of about one part in 10^6 of helium 4, has been done by Daunt at Columbus and Lane at Yale with the mass-spectrographic collaboration of Nier at Minnesota. Lane has found that the vapour above the surface of liquid helium has a higher concentration of helium 3 than has the liquid, which indicates that if pure helium 3 can exist as a liquid, then its normal boiling point will be lower than that of helium 4. Daunt has further shown that helium 3 does not participate in the surface transfer of liquid helium II, which means that helium 3 is not in the superfluid state, at least at temperatures above 1·5° K., whereas helium II loses its superfluidity at 2·19° K. The fact that helium 3 is not superfluid offers the possibility of considerable enrichment of the helium 3 content by 'straining' helium II through a porous plug—called by the Americans a 'superleak'. It was rumoured in America that there exists a small quantity, of the order of 1 c.c., of pure helium 3, but not produced by the above means.

Other research on helium II at Yale consisted in investigations on second sound, in which, among other things, an attempt was being made to convert ordinary sound into second sound by passage of the waves through a porous membrane. At the Massachusetts Institute of Technology, Squire has made an investigation of the attenuation of ordinary sound, of ultra-sonic frequency, in liquid helium. Here the most important feature is the fact that the absorption rises to an indefinitely high maximum at the λ-point.

Among other researches in progress, Andrews at Johns Hopkins is investigating the phenomenon which he has discovered of the 'rectifying' property of the transition region in superconducting niobium carbide, which occurs in the neighbourhood of 15° K. One of the odd features of this phenomenon is that at a suitable temperature and with a suitable biasing current through it, the carbide specimen can pick up the local radio station with the aid of an amplifier and loud-speaker.

Boorse, at Columbia, is also planning to investigate niobium carbide and nitride, but from the magnetic point of view. He has a Simon expansion liquefier. Brickwedde, of the U.S. Bureau of Standards, also has a Simon liquefier of about one quartre-litre capacity. Aside from his calorimetric work, he is investigating the so-called 'overshoot' phenomenon in superconductivity which he discovered some years before the War. Some criticism has been expressed of the reality of this phenomenon, which involves very high measuring currents, owing to the possibility of local temperature fluctuations, and he is planning to repeat the investigations on indium, which has a transition temperature in the helium II region, where temperature fluctuations are much more difficult to produce.

None of the cryogenic laboratories visited are at present engaged on magnetic cooling experiments, although one or two of them intend to commence such work within the next year or two.

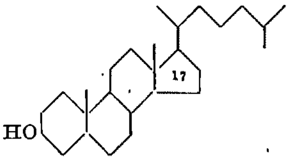
TOWARDS THE SYNTHESIS OF CHOLESTEROL

By Dr. J. W. CORNFORTH and Sir ROBERT ROBINSON, F.R.S.

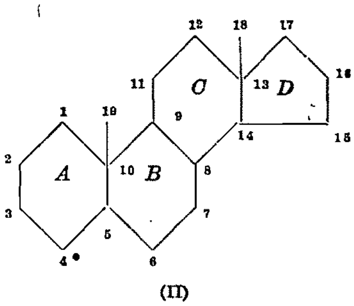
National Institute for Medical Research and Dyson Perrins Laboratory, University of Oxford

No development of organic chemistry or of biochemistry has unfolded in a more dramatic manner in recent years than that concerned with the nature and functions of the steroids, the bile acids, and the related vitamins and hormones.

The typical compounds, cholesterol and cholic acid, excited the curiosity of Windaus and of Wieland because of their complex and obviously interesting molecular constitution; and the brilliant researches of these pioneers were supplemented by contributions from many other laboratories, especially when discovery of the biological significance of the group came to light. The chemical puzzle was transformed into a problem of vital urgency for physiology and medicine. The outcome has been that the structures of the chief members of the rapidly expanding family of substances are known in so far as that is possible without the final confirmation of successful synthesis. This latter task has been regarded as one of the most difficult that could be undertaken by the organic chemist, for the simple reason that it is far from sufficient to devise a method of constructing a substance corresponding to the formula as written on paper, difficult though that may be in itself. The molecule of dihydrocholesterol (I) contains nine asymmetric carbon atoms, and hence 512 stereoisomeric forms are possible. There is reason to believe that all these should be capable of existence. Even if the side-chain is not present, and position-17 carries a carbonyl group, there are still 128 stereoisomeric modifications. It is a triumph of analysis that a combination of chemical and physical methods, culminating in the X-ray crystallographic studies of cholesteryl iodide[1], has disclosed the stereochemical configuration of the ring-systems (cf. II) in the best-known steroids.



(I)

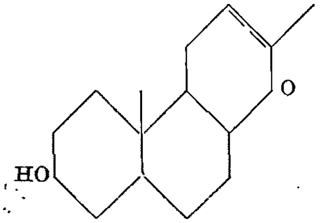


(II)

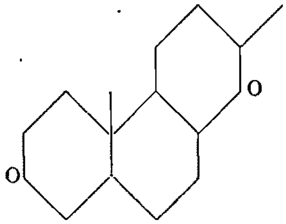
Rings *A* and *B* are fused together in the *cis*-position (coprosterol, cholic acid) or *trans*-position (dihydrocholesterol) in various derivatives, whereas rings *B* and *C* are fused in the *trans*-position in all known cases. For any given orientation of rings *A* and *B*, there are two such *trans*-fusions of *B* and *C*. Expressed in a different way, the configuration of C-9 must be established correctly in relation to C-10; that of C-8 must then be correct in relation to C-9. It is not necessary at this stage to discuss the fusion of rings *C* and *D*.

After a long series of investigations in other directions, we selected a synthetic route which had the useful feature that the stereochemical vagaries were placed under the maximum of control. The ring *A* was added to *B* : *C* in such a way that modification of ring *A* was feasible, while C-9 and C-8 (of II) were not yet asymmetric centres. It was shown at this stage that *cis*-fusion of *A* and *B* had been effected. The asymmetric centres at C-9 and C-8 were then set up, from analogies in *trans*-relation, and a separation of two series achieved in which the relation C-9 : C-10 was in the two possible senses. In this way a tricyclic substance was obtained which was convertible into a derivative of a tricyclic degradation product of desoxycholic acid. We have also completed the transformation of a cholesterol degradation product into the same substance. Thus sixteen carbon atoms have been joined in the space arrangement obtaining in coprostanone (for exactness), and the first synthetical proof of the existence of an angle-methyl (C-19) attached to C-10 has been given.

The Tricyclic Degradation Products. The oxidation of methyl O-diacetyldesoxycholate by means of chromic acid[2] afforded a number of neutral products in small yield. After hydrolysis, Reich[3] showed that one of these is an unsaturated keto-alcohol the constitution (III) of which follows from that of desoxycholic acid. By reduction, followed by oxidation, III gave a saturated diketone (IV).

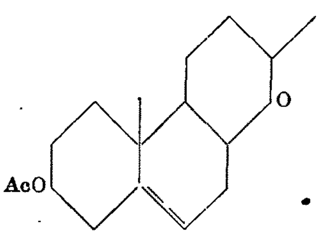


(III)

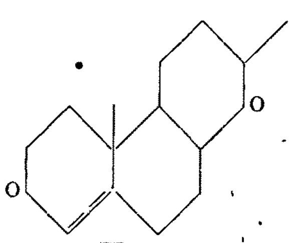


(IV)

Köster and Logemann[4] obtained (V) by suitable treatment of the mother liquors from the oxidation of cholesteryl acetate dibromide, after separation of acetates of dehydroandrosterone and pregnenolone. A small quantity of (V) was kindly supplied by Dr. K. Miescher of the Research Laboratory, Pharmaceutical Department, Ciba Company, Basle. By successive hydrolysis, oxidation (to VI), and reduction (a new stage), it was converted into (IV) (Specimen *A*). Specimen *B* is the Reich diketone (IV), for which we are indebted to Dr. H. Reich and Prof. T. Reichstein. Specimen *C* is the synthetic diketone (IV). We are very grateful to our Swiss colleagues for their generous help.



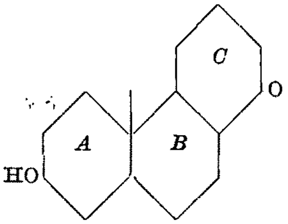
(V)



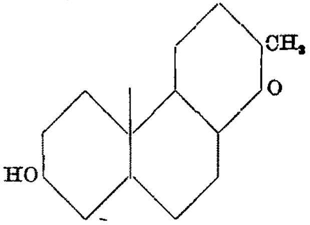
(VI)

The melting points, mixed melting points, and rotatory powers of *A*, *B*, and *C*, showed them to be identical. Dr. D. Crowfoot was able to use single-crystal technique for the examination by X-ray methods and has reported the complete identity of the three specimens. We are greatly obliged to her for such a satisfactory investigation made on the eve of a journey to the United States.

The Method of Synthesis. The preparation of (VII) from 1 : 6-dihydroxynaphthalene has already been described[5]. Considerable modifications and improvements have since been made in the details of the necessary operations, and transformations of the intermediate products have been realized such as to prove that rings *A* and *B* in (VII) are in *cis*-relation.



VII) (*A* and *B*)



(VIII) (*A* and *B*)

Although early specimens of (VII) were homogeneous (*A*-isomeride), it became evident, when larger quantities were available, that two isomerides were produced. These were first recognized after the preparation of the hydrogen succinates, which derivatives still afford the best method of separation. After hydrolysis, the hydroxy-ketones *A* and *B* are obtained in the ratio of about 6 :1. On oxidation they yield diketones *A* and *B*, so that their isomerism is not wholly (and probably even not partly) dependent on the configuration of the *sec*-alcoholic group. It must be connected with the mode of fusion of rings *B* and *C*. But (VII) is an α-decalone and has been subjected to treatment which is known to convert *cis*-α-decalone into the *trans*-isomeride. Hence the hydroxy-ketones (VII), *A* and *B*, probably represent the two possible *trans*-fusions of rings *B* and *C*. The optical resolution of the hydroxy-ketones *A* and *B* was then studied.

In the *A*-series, the crystallization of the *l*-menthoxyacetates was applicable and both enantiomorphs were obtained in a pure condition; m.p. 120·5–121·5°; $[\alpha]_D^{24}$ ± 38·5° (± 2°) in chloroform. In the *B*-series crystallization of the brucine salt of the hydrogen succinate afforded the pure derivative of the *B* (−) hydroxy-ketone. The *B* (+) hydroxy-ketone (VII) could be purified as the hydrogen succinate and was also obtained in a pure condition; hemihydrates, m.p. 113–114°; $[\alpha]_D^{24}$ ± 10° (± 0·5) in chloroform. Only 1·132 gm. of the *B*-isomeride hydrogen succinate was available for this resolution.

For the introduction of a methyl group in the 2-position (phenanthrene numbering), the method of Sen and Mondal[6] was employed; namely, successive formylation, methylation and hydrolysis. The hydroxymethylketones (VIII) were then oxidized to give two pairs of methyl-diketones of the structure (IV).

The methyl-diketones-*A* had m.p. 141–142°, $[\alpha]_D^{25}$ ± 20° (± 2°) in chloroform. The methyl-diketones-*B* had m.p. 116·5–117·5°, $[\alpha]_D^{25}$ ± 25° (± 2°). Reich[3] attributes m.p. 119·5–121° to his specimen *B*, but this melting point was taken on the Kofler-block and corrected (± 2°). Under our conditions the specimen provided had m.p. 116·5–117·5°. The same was true of specimen-*A*, made from the Köster–Logemann keto-acetate. Mixtures of the specimens had the same melting point. A full account of the experiments briefly summarized herein will be published in another place.

Prognosis. The synthesis of the tricyclic degradation product undoubtedly opens the way to a total synthesis of cholesterol and its ramifying derivatives. Referring to (II), the configuration of positions 5, 10, and 9 is secure, and that at 8 is also unlikely to be affected by subsequent changes at 14 and 13. We now propose to add ring *D* in a simple manner and hope to obtain two isomerides dependent on the relation of configuration C-13 to C-9. If that is found possible, the total synthesis becomes a matter of routine and eventually will certainly be accomplished.

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[1] Carlisle and Crowfoot, *Proc. Roy. Soc.*, A, 184, 64 (1945).

[2] Reich and Reichstein, *Helv. Chim. Acta*, 26, 2102 (1943); 28, 863 (1945).

[3] Reich, *Helv. Chim. Acta*, 28, 892 (1945).

[4] Köster and Logemann, *Ber. Deut. Chem. Ges.*, 73, 299 (1940).

[5] Cornforth and Robinson, *J. Chem. Soc.*, 676 (1946).

[6] Sen and Mondal, *J. Ind. Chem. Soc.*, 5, 609 (1928).

PESTS OF STORED FOODS

FOOD AND AGRICULTURE ORGANISATION CONFERENCE

A MEETING of scientific workers concerned with pests of stored food was held in London in the week of August 4. The meeting was opened by Sir John Boyd Orr, director-general of the Food and Agriculture Organisation, who urged the delegates to propose methods which would enable Governments to preserve the 1947 harvest.

The subjects discussed included the appraisal of food losses; the spread of pests throughout the world; specific methods of control of insects and mites, of rodents and of fungi; storage methods; the world supply position of poisons; the dissemination of knowledge; and research needs. The chair was taken throughout by W. McAuley Gracie (United Kingdom), who contributed the opening paper on the economic significance of infestation. Most of the scientific papers were on the control of insects and mites. R. T. Cotton (United States) and H. E. Gray (Canada) presented comprehensive studies on the preservation of cereals from insect attack during storage. J. A. Freeman (United Kingdom) gave an account of world foci of infestation and channels of its dissemination, with suggestions for detection and standards of inspection. Prof. R. Mayné (Belgium) spoke on conditions and control methods in his country; R. Attia (Egypt) on conditions in both modern and ancient Egypt; K. R. Söntakay and H. S. Pruthi (India) on traditional Indian methods of storage and on modern rat-proof construction; Prof. P. Vayssière (France) on the principle of air-tight ensilage. A detailed account of the methods of grain drying was given by T. A. Oxley (United Kingdom).

On rodents, E. R. Kalmbach (United States) sent a paper on rodent control in the United States, and S. A. Barnett (United Kingdom) gave an account of the principles of rodent control based on the work carried out in Britain during the War.

The secretary of the Conference, S. S. Easter (Food and Agriculture Organisation), gave a report on estimates of losses due to infestation of stored foods. It was agreed that it is quite impracticable to give any reliable estimate of losses for any large area. Various estimates were quoted, including the statement that 10 per cent of the world's stored food is destroyed by pests. It was, however, considered that all such estimates are likely to be below the mark, owing to the high proportion of food stored in small lots by peasant farmers and not entering world trade.

The methods of insect control include fumigation, spraying and dusting, as well as preventive measures such as grain-drying and improvement of hygiene and of building construction. The committee on grain-drying urged that a world-wide study of this problem should be made, so that improved methods could be devised for each area. Economic as well as technical problems are involved, since drying grain reduces its weight; and if the grain is sold by weight, this may entail loss to the producer.

For rodents, the sub-committee urged the general adoption of the method of poisoning, preceded by prebaiting with plain bait. This method, based on research at Oxford during the War, can ensure almost complete clearance in most areas if it is rigorously applied. Again, the preventive measures of improvement of hygiene and buildings were recommended; but it was pointed out that in many areas they can be part only of a long-term project.

Inevitably, the meeting became involved in the discussion of wider problems. There was complete agreement that every country needs a pest control organisation with a staff of trained persons, including scientific investigators and operators. International agreement on certain aspects of pest control organisations is also required. This is exemplified by occurrence of the transfer of pests from one country to another by ship. The transport of rats is an old story, and the damage has already been done. But the transport of some serious insect pests is a recent affair and is still going on. For example, the mill moth (*Ephestia kühniella*) was first noticed as a pest of mills in Germany in 1877; by about 1900 it had a world-wide distribution, and it now costs the British milling industry alone some thousands of pounds a year for cleaning and fumigation, apart from the losses due to infestation of flour and offals. Similarly, the spider beetle (*Ptinus tectus*) was unknown in England before 1892. By 1916 it had spread all over the country and is now to be found in every warehouse in Britain. Its original home was probably Tasmania. Neither of these species is to-day often intercepted on imports; but, had an adequate quarantine service been in operation in the late nineteenth century, the entry of both might have been prevented. During the past few years the Government organisation has intercepted insects not hitherto recorded in the United Kingdom, and in some instances previously undescribed species. The delegates of other countries, and notably Belgium and France, recorded experiences similar to those in the United Kingdom.

Within each country the need for a pest control organisation raises a number of problems which have a more general application than to pest control alone. Prof. J. W. Munro (United Kingdom) gave a paper on the dissemination of information. He dealt first with the need for improvement in the information services available to scientific workers, and in particular, of abstracting services. This, as always, commanded general support. He then went on to refer to the problem of keeping administrators adequately informed. The extent to which administrators seek, or are given, advice varies greatly in different countries, and at different times in the same country. In times of crisis advice is readily sought, often when it is too late; at other times it may not be sought at all, and if offered, it may be disregarded. The meeting, said Prof. Munro, gave an opportunity of ensuring that scientific opinion was heard in high quarters, and he hoped that the meeting would state the strongest case it could to that end.

Finally, Prof. Munro and many others referred to the need for the education of transporters, warehouse-keepers, millers, wharfingers and the general public. A few countries have done a good deal in this direction, and Denmark gave an example by showing an entertaining film illustrating how bad hygiene and ill-kept buildings encourage infestation. At the other extreme there are the backward countries, mainly in the tropics and sub-tropics. The delegate from Siam gave examples of the formidable problem of educating peasant farmers in pest control. It was, however, pointed out that there is much ignorance to be combated even in the more advanced countries, where it is still common to find farmers and traders who believe in spontaneous generation.

Delegates visited the Ministry of Agriculture and Fisheries Infestation Control Division building, the Pest Infestation Laboratory at Slough, a large-scale grain drying plant, an exhibition of food pests at the British Museum (Natural History) and a number of demonstrations on pest control methods.

The Proceedings of the meeting are to be published by the Food and Agriculture Organisation.

S. A. BARNETT
R. A. DAVIS

FUEL ECONOMY CONFERENCE OF THE WORLD POWER CONFERENCE

By DR. H. E. CROSSLEY
Fuel Research Station, Department of Scientific and Industrial Research

THE Fuel Economy Conference of the World Power Conference was opened at The Hague on September 2 by His Excellency Dr. G. W. M. Huysmans, Netherlands Minister of Economic Affairs, who was introduced by Mr. G. J. T. Bakker, chairman of the Conference. Dr. Huysmans welcomed the representatives of thirty-three countries, and told them that the critical world shortage of fuel gave additional importance to the deliberations of the Conference. It was hoped that the exchange of views on many aspects of fuel economy would be helpful to all the nations, and that the personal contacts made at the Conference would lead to collaboration in the future. The official delegates from Great Britain and France thanked the Dutch authorities for their hospitality, and looked forward to profitable discussions.

The opening speeches were followed by a lecture on "Atomic Energy for Peaceful Purposes", given by Prof. G. J. Sizoo. He pointed out that estimates of the economics of energy production by atomic fission, or of the size or nature of fission plants, are purely speculative, and often optimistic. In his opinion, atomic fission would probably become a supplementary source of energy, rather than a replacement of other sources. The alternatives of peaceful or aggressive use presented a challenge to mankind.

The first technical session of the Conference was a discussion of reports from nineteen countries on "Fuel Economy since 1939". These reports indicated the need for the direction of all fuels to the uses for which they are most suitable, to avoid many operational troubles and to provide higher efficiencies. The British report was appreciated for the account of ways by which the public have been informed of the more efficient use of fuels. A resolution was passed asking the International Executive Council of the World Power Conference, in consultation with the national committees, to consider the collection of target values for energy consumption per unit of product or effort, for discussion and publication. This resolution was later approved in principle by the International Executive Council.

Subsequent sessions were more specialized in character, as indicated by the following examples.

One session was concerned with liquid fuels, the subject of seven papers. The papers and the discussion showed the great interest in home production of liquid fuels from indigenous sources such as shale, oil sands, tar oil and wood. The commercial development of indigenous sources is, of course, dependent on the cost of imported fuels, and the quantities available for import. Dr. W. H. Zaaijer directed attention to the difficulty in several European countries of preparing motor spirit with a sufficiently high octane number, and suggested that production plants would have to be modernized to meet this demand.

In a session concerned with domestic appliances, the main subject of discussion was the desirability of having quality marks stamped on such appliances. These quality marks would be defined by standard specification of performance and design, and in consequence domestic appliances would be more efficient, and should be cheaper, due to the standardization of parts. It was felt that co-operation between appliance manufacturers and gas companies would be the best way of sponsoring advancements in the design of gas appliances. Co-operation is needed also between the gas and electricity industries, to avoid the production of undesirable appliances purely for competitive purposes.

The use of fuels for transport purposes was discussed in another session. Papers from Sweden and France showed the wastefulness of steam traction compared with electrical traction, the former requiring 2·5–3·25 times the amount of coal needed by the latter for the same load. In the United States Diesel traction is being favoured, particularly for branch line and shunting operations.

The session concerned with industrial and agricultural appliances received the largest number of contributions, twenty papers being submitted for discussion. These papers dealt with a variety of subjects, such as the use of low-grade fuels in various types of boilers and other furnace plant, the recovery of heat from waste liquors, the development of the gas turbine, and the significance of convection and radiation in heating by gas. It was stated that Britain alone had been frank in publishing operational troubles with power station boilers, and this frankness had been made possible by the collaboration of power station engineers and boiler manufacturers on the

British Boiler Availability Committee. Contacts with other countries were sought by this Committee, for the exchange of information and experience, and it was suggested that the structure of the Committee was worthy of emulation in many countries.

Four papers were submitted to the session concerned with the character of national fuel reserves, from Great Britain, Canada, the United States and France. The British contribution explained how the Coal Survey Section of the Fuel Research Organisation (Department of Scientific and Industrial Research) had helped in the production and preparation of coal, and in its storage, distribution and utilization.

Great interest was shown in the session concerned with atomic energy, although few members were able to offer contributions. It was thought possible that two kinds of fission furnace may be developed, one to use uranium 238, involving the preliminary conversion of this substance into fissile material such as plutonium, the other to use directly fissile material, such as plutonium, uranium 235 and 233. The second type of furnace would be much smaller than the first, but the material used by the first would be much more plentiful. Only 1/139 of the uranium in the earth's crust is directly fissile. If it became possible to use natural uranium, 170 tons per annum would satisfy the energy requirements of the world. Dr. W. Lulofs considered that as the world's supply of uranium would not be inexhaustible, it might be necessary to look for further sources of energy. For example, he wondered if it would be possible to build up helium from hydrogen, setting free a considerable amount of energy. Dr. J. D. Cockcroft replied that physicists had given such matters considerable thought, but with regard to the example cited, the necessary extremely high temperature is, as yet, prohibitive of progress. Several speakers considered that there had been over-optimistic views all over the world regarding the early development of atomic energy for industrial use. It is clear that many difficult problems have still to be solved before that hope can be realized; and at this stage the prospect is that atomic fission will have little, if any, financial advantage over present methods for the production of energy. It would, of course, set free very large amounts of fuels for other uses.

Other sessions considered developments in coal mining and coal preparation, economy measures in the production of gaseous fuels, the transport of gas, the transmission of electricity, and space heating. Several papers directed attention to the advantages arising from district heating in suitable towns.

The Netherlands National Committee, and an associated Committee of Ladies, arranged various technical and non-technical excursions. Facilities were provided for visits to the refineries and laboratories of the Bataafse Petroleum Maatschappij at Pernis, Delft and Amsterdam, the Philips works at Eindhoven, and the various works associated with the Netherlands State Coal Mines near Lutterade. Appreciation was expressed by all the members for the excellent organisation of the Conference and the arrangements made for the visits to works, laboratories, and places of general interest. The exchange of views and experience on the urgent question of fuel economy was felt to be most valuable and a real contribution towards the goal of economic recovery. The Conference had an even greater value in showing the benefits that can arise from a meeting of representatives of the countries of the world in a friendly spirit.

OBITUARY

Sir Albert Howard, C.I.E.

BOTANISTS, agriculturists and many others will learn with regret that Sir Albert Howard died in London on October 20. He was born in 1873 and educated at the Royal College of Science and at St. John's College, Cambridge, where he was a foundation scholar. Here he worked under Marshall Ward, who was then attracting a brilliant group of students to some of the newer aspects of botanical science, and after taking first-class honours in the Natural Science Tripos in 1898, he proceeded in 1899 to the Imperial Agricultural Department for the West Indies, then newly established with the purpose of applying science to the difficult problems raised by the threatened collapse of the sugar-growing industry there. In 1903 he returned to England to succeed F. Escombe as head of the Botanical Department of the South Eastern Agricultural College, Wye, Kent. He was not, however, entirely happy at Wye, and left in 1905 to become Imperial Economic Botanist to the Government of India, where for the first time he found full scope.

In the same year Howard married Gabrielle Louise Caroline Matthaei, of Newnham College, who was already well known for her investigations on vegetable respiration and assimilation, and they worked together for nearly twenty years at Pusa in so close a collaboration that no one knew which part was hers and which was his. Their first work was on wheat, and they were fortunate in having available an important collection of varieties brought together by W. H. Moreland and grown continuously on the Cawnpore Experimental Farm by J. Haymon, the first deputy director of agriculture, and by Bryce Burt. At that time there was a considerable export of wheat from India to England, and the Howards sought varieties giving better yields than those commonly grown, and possessing more 'strength' as defined by the English millers. Fortunately, one or both of the Howards had the artist's eye for picking out the varieties likely to do well and those that would not, and their final selections and crosses proved remarkably successful, particularly Pusa 4 and Pusa 12 in the United Provinces and the North West Frontier Province. An account of this work was given in "Wheat in India, its Production, Varieties and Improvement" (1909), and a general summary of all their work up to 1929 in "Crop Production in India" (Oxford University Press).

While at Pusa the Howards in 1912 started a Fruit Experiment Station at Quetta, a district long known for fruit-growing; it was, however, abandoned in 1919. It was re-started in 1933, but no records of the older work could be found, nor were the surviving varieties suitable for the new conditions.

In 1924 the Howards left Pusa for the new Institute of Plant Industry, Indore, established to provide a farm for Bernard Coventry, agricultural adviser to the States in Central India. The general principle underlying their administration was that the crop was to be treated as a unit and studied in relation to the field and the village; there was to be no division of the scientific work into departments. A joint book, "The Application of Science to Crop Production", was published in 1929. Unfortunately, in 1930 Mrs. Howard died, and the long and fruitful partnership came to an end. Howard himself left India in 1931; he was knighted in 1934.

At Indore, Howard had worked with Y. D. Wad on composts. These have long been known in the East, and they have the double advantage of supplying much-needed organic matter to the soil, and of affording the means of keeping the villages cleaner than would otherwise happen. No new principle was involved in the work, but his enthusiastic, even passionate, advocacy served the valuable purpose of greatly extending the use of composts. Howard, however, went further and introduced ideas regarded by scientific workers as going beyond the experimental evidence. He embodied these in two books, "An Agricultural Testament" (1940) and "Farming and Gardening for Health or Disease" (1945), and they were ably and persuasively set out in "The Earth's Green Carpet" (1947) by his second wife, Louise E. Matthaei, an associate of Newnham College and formerly chief of the Agricultural Service of the International Labour Office, Geneva. Whatever the fate of these ideas, they have caused scientific workers in agriculture to re-examine the foundations on which their hypotheses are based—always a useful exercise.

Howard was active almost to the end. For a day or two he had been slightly unwell, then came a heart attack from which he did not recover. E. JOHN RUSSELL

NEWS and VIEWS

Scientific and Technological Man-Power in Great Britain

THE report of the Committee on Scientific Man-Power (Cmd. 6824), it will be remembered (see *Nature*, June 15, p. 794, 1946), was based on the work of the Barlow Committee; both reports emphasized the vital need for increasing the output of trained men of science and technologists in Great Britain. In order that the part which universities and technical colleges will be called upon to play in this connexion may be estimated with greater accuracy than has been possible hitherto, the Advisory Council on Scientific Policy has asked for the help of the Technical and Scientific Register of the Ministry of Labour and National Service in measuring the existing man-power in the scientific and technological fields; to do this a comprehensive questionnaire is being sent out. The purpose of the survey is solely to obtain as complete an analysis as possible of the existing scientific and technological man-power in the United Kingdom and overseas in respect of its distribution in age groups between Government, industry, university and school teaching, and to use this analysis for estimating in which of the sciences it will be necessary to take special steps for increasing the output of the universities and technical colleges because of exceptionally heavy demands for home and overseas posts, previous and continuing shortages, or the high average age of any particular group. In asking for the completion of the questionnaire, the Ministry states categorically that the information provided will in no circumstances be used as a basis for any form of administrative control or direction. It is not being sought as a means of revising the Technical and Scientific Register of the Ministry of Labour.

A complementary inquiry is being conducted by the Ministry of Labour by specially appointed sub-committees of the Technical Personnel Committee presided over by Lord Hankey. These inquiries are designed to establish as nearly as possible the demands likely to be made by industry, teaching and Government service, both at home and overseas, in the various branches of science and technology during the next five to ten years, and committees have been set up to deal with chemical engineering, architecture and surveying, engineering, microbiology, entomology, geology and physics. The Committee on Chemical Engineering completed its work last year; draft reports have been prepared for architecture, surveying, microbiology and entomology; the engineering inquiry is well under way; and those into physics and geology have been commenced. It is hoped to set up a further committee in the immediate future to inquire into the future demand for chemists and metallurgists.

Committee on Science and its Social Relations

THE Committee on Science and its Social Relations, instituted by the International Council of Scientific Unions in April 1937, held its first post-war meeting in London during September 11–12. The members from the United States and from China were unable to attend, but Dr. V. Weiskopf from Cambridge, Mass., was present. A considerable part of the meeting was devoted to a discussion of the dangers facing the world from the possibilities of misusing science for war. The failure thus far to establish a world control of atomic (nuclear) energy is extremely embarrassing. Every effort towards a better understanding of the issues and dangers ahead must be supported by all means. Equally menacing dangers are connected with the possibilities of using bacteriological infections or poisons, control of which is far more difficult than that of atomic energy. It is important that those responsible for the strategy governing the armed forces of the United Nations should bear fully in mind the implications of these new weapons and of the speed with which they can be brought into operation. Equally, it is important to develop throughout the world a public opinion fully informed of the danger and strongly supporting measures leading to peace and international understanding. The whole future of the world depends on this. Much attention was also devoted to the position in which science has arrived through the legal secrecy restrictions now introduced in a number of countries; and through the support of scientific research by grants from military authorities and from industry.

The Committee decided to resume the work started before the War of making surveys of the social position of science in various countries. For this purpose the organisations adhering to the International Council (national academies and the like) will be asked to set up committees in each country to collect a number of specified data. Such a national committee, consisting of private individuals, already exists in Denmark and has done extremely valuable work there. Help will also be asked of the United Nations Educational, Scientific and Cultural

Organisation for countries not represented on the International Council; and contact will be made with the International Labour Office, the Food and Agriculture Organisation, the Economic and Social Council of the United Nations Organisation, and with the International Federation of Scientific Workers, in order to avoid duplication of work in so far as these bodies might have made inquiries of similar nature. The International Federation of Scientific Workers will also be approached concerning a charter of rights and obligations for scientific men.

Marconi Jubilee and Congress in Rome

As already recorded in *Nature* (May 3, 1947, p. 598), it is just fifty years ago that Marconi gave the first successful demonstration of wireless signalling in Great Britain. The fiftieth anniversary of the foundation of the Marconi Company was on July 20, and to mark the occasion a souvenir brochure was produced ("Jubilee Year, The Marconi Company." Pp. 58. Published by Marconi's Wireless Telegraph Co., Ltd., Chelmsford, 1947). This volume provides a brief and very interesting account of the development of wireless signalling by the Company, from the first practical transmissions over a few miles to the achievements attained in the fields of broadcasting, television and radar. The brochure is profusely illustrated by a large number of excellent photographs, many of which have a unique historical interest.

To mark the occasion of the Marconi Jubilee, the Italian National Council of Research held an International Congress in Rome during September 28–October 4. The Congress was attended by about two hundred delegates from some twelve countries: there were seven British delegates representing the Royal Society, Physical Society, Institution of Electrical Engineers, Government departments, both civil and military, and the radio industry. The technical part of the Congress comprised the presentation of a large number of scientific and technical papers describing progress in various fields of radio technique during the past twenty years or so. It is understood that these papers will be collected together and published in a special commemoration volume. Apart from one or two social events, the Congress visited the main transmitting station of the Italian Radio and Cable Co., some ten miles out of Rome. This station was extensively damaged during the War; but several long-distance short-wave circuits are now in operation. A special visit was also paid to Castel Gandolfo, at which the whole Congress was addressed by the Pope. The programme of celebrations provided the usual opportunities of meeting delegates from other countries and discussing matters of mutual interest in radio and allied fields.

Development of Insecticides and Weed-killers

TEN years ago, Plant Protection, Ltd., was formed to take over the agricultural and horticultural interests of Imperial Chemical Industries, Ltd., and Cooper, Macdougall and Robertson, Ltd., and a dinner was held recently in London to celebrate the achievements of the first decade. Replying to the toast of "Agriculture" proposed by Mr. S. W. Cheveley, managing director of the firm, Prof. Scott Watson outlined some of the remarkable advances made in recent years in the discovery and production of new insecticides and selective weed-killers. Plant Protection, Ltd., has been in the forefront of these advances. It has recruited research workers and formed an advisory service to study all aspects of the products that it markets, and give advice on how to use them. This service is international in scope. The Research Station at Fernhurst, which was taken over nearly two years ago, serves as a training centre for the technical staff as well as a research centre and demonstration centre. The Imperial Chemical Industries research stations of Hawthorndale and Jealott's Hill examine chemicals that may prove useful in plant culture, from the whole of the Imperial Chemical Industries organisation, and those that prove useful are passed on to Plant Protection, Ltd., for technical development, which is carried out at Yalding and Fernhurst. In addition, chemicals from sources outside Imperial Chemical Industries are examined and may be incorporated in the firm's range of products. Perhaps the firm's most notable contribution to the field of pest control is the production of 1,2,3,4,5,6-hexachlorocyclohexane in the 'Agrocide' range of products containing 'Gammexane'; but notable contributions have also been made to the study of plant hormones and the technique of application of seed dressings. The firm has also at its disposal the accumulated experience of Cooper, Macdougall and Robertson, Ltd., in the field of derris insecticides, a field in which they were pioneers. Plant protection is becoming, or has become, a matter for specialists, and Plant Protection, Ltd., has recognized this fact and is organising accordingly.

The Profession of Chemistry in India and Pakistan

PROF. ALEXANDER FINDLAY, past president of the Royal Institute of Chemistry, accompanied by Mrs. Findlay, is to visit important centres of scientific activity in India and Pakistan. The main purpose of his mission is to study the steps that are being and might be taken in the two Dominions to ensure that due provision will be made, and on an increasing scale, for students to receive proper training in the science of chemistry and for a fuller recognition of the status of the profession. Prof. Findlay hopes to be present at the meeting of the Indian Science Congress and the annual meeting of the Indian Section of the Royal Institute of Chemistry at Patna in January 1948, as well as at the subsequent inauguration of the examinations for the associateship of the Institute at Bangalore.

Estimated Weight of the Largest Bird

IN *The Condor* of July–August 1947 (49, No. 4), Dean Amadon gives an account of an investigation which he has made into the weight of the largest known bird. The ostrich (*Struthio camelus*), largest of living birds, was far surpassed in size by the elephant bird (*Aepyornis maximus*) of Madagascar; the larger of the New Zealand moas such as *Dinornis* were intermediate in size. The moas and elephant birds were exterminated by the natives of these islands and are known only from sub-fossil remains of skeletons, eggs and feathers. From available evidence, Amadon estimates that *Aepyornis maximus* weighed about 965 pounds and *Dinornis* about 520 pounds. This compares with a weight of about 250 pounds for the ostrich.

A Study of Cultural Phenomena

IN an article entitled "The Expansion of the Scope of Science" (*J. Washington Acad. Sci.*, 37, No. 6; June 15, 1947), Leslie A. White attempts to assess the ages and degrees of maturity of the sciences. The following 'law' is stated: "Scientific interpretation will appear to grow fastest in those areas where the determinants of human behaviour are the weakest and least significant". These determinants are least effective where the identification of the self with the external world is weakest; that is, in relation to the heavenly bodies and other inanimate objects; hence the success of astronomy, physics and chemistry. The new interpretation has then spread to the biological sciences: anatomy, physiology, psychology and sociology, in that temporal order. Dr. White regards the latest science, culturology, as in a sense superior to all the others. Many sociologists and anthropologists, for example, Ralph Linton, Robert S. Lynd and Margaret Mead, agree that the study of culture is often neglected, and approve a present tendency to study personality in its cultural background or context. But Dr. White disapproves strongly of what he calls "the exponents of 'free will' in anthropology", yet when he writes "present day anthropology is both anti-evolutionist and anti-culturological" the reader may wonder what he means by free will, evolution and culturology.

Dr. White believes that culture traits react upon each other immediately and directly. He quotes the hoe as an example. It acts upon and influences other culture traits "such as division of labour between the sexes, customs of residence, food habits, religious beliefs and ceremonies and so on". But a hoe may act upon a clod, the hoer's foot or remain unused; and to-day fashions for or against certain tools or instruments are notoriously affected by propaganda and advertising. All these are examples of human interference. We are asked to treat cultural phenomena "as if they had a life of their own". But the instances the author quotes, where "the introduction of human organisms into a consideration of these problems is not only not necessary; it is irrelevant and confusing" can be claimed as examples of problems the solution of which is impossible if the effect of human beings is excluded. Even "studies of languages on a purely linguistic, i.e., non-biological level" are sadly incomplete if one ignores the living, speaking creature. Dr. White states his belief that culture has its own laws, but for this the present article offers little evidence.

Commonwealth Fund Fellowships

The Commonwealth Fund of New York, a philanthropic foundation existing since 1918 and supported by endowment from the late Mrs. Stephen V. Harkness and the late Mr. Edward S. Harkness, has established for British subjects a number of fellowships tenable in the United States. Not more than twenty ordinary fellowships will be offered in 1948. Candidates must be of British descent, graduates of recognized universities of the British Commonwealth, and be between the ages of twenty-three and thirty-five on September 1, 1948. Not more than five service fellowships will be available for candidates of British descent who hold Government appointments overseas in the British Commonwealth. Not more than three Home Civil Service fellowships will be offered for candidates holding appointments in the Home Civil Service. None of these fellowships is open to women. There is no fixed stipend; but it is estimated at a minimum of approximately 3,500 dollars for twelve months, and is intended to cover the full expenses of residence, study and travel in the United States during the year. All applications must be submitted on the prescribed form, and must be approved by the authorities of the college or university of which the candidate is, or has been, a member. They must reach the Secretary to the Committee, Richard H. Simpson, Commonwealth Fund Fellowships, 35 Portman Square, London, W.1, by February 1, 1948.

Volcanic Activity in 1946

According to *Earthquake Notes*, **18**, Nos. 1 and 2, September 1946, the first new volcanic activity of 1946 was on February 17 when a volcano on Niuafoou in the Tonga Islands erupted violently and the lava flow partly covered a village. In the same month, in Baluchistan, a volcano north of Karachi, India, began emitting mud, and 200 miles south of Yoksuka naval base, Japan, a volcanic island rose from the sea. On March 20 Mount Sakura-Jima in southern Japan blew boulders more than 1,000 ft. into the air and sent up a smoke column 3,000 ft. high. Lava flows doomed nearby villages. On May 11 Izalco volcano in El Salvador erupted after twelve years quiescence. Santiago volcano in Nicaragua began smoking in June. On September 25 Stromboli in Italy was again active. Continued activity was reported from Kluchenskayo volcano on the Kamchatka Peninsula, which erupted in December 1944, while in New Zealand, Mount Ruapeku continued to shower dust over a wide area after the outbreak in August 1945. Paricutin volcano was intermittently active during the year, but there was an overall subsidence. Volcanic ash, reported over the Aleutian Trench in 1945, was later found to be due to a spectacular eruption on Umnak Island, which blew steam and ash several thousand feet into the air.

Chemical Composition of the Stars

A recent paper by Mr. F. Hoyle introduces some revolutionary conceptions regarding the internal constitution of the stars (*Mon. Not. Roy. Ast. Soc.*, 106, 4; 1947). Until comparatively recently it was usually assumed that the stars contain about 30 per cent of hydrogen and 10 per cent of the heavy elements; but an accumulation of observational evidence during the last fifteen years indicates that this proportion of the heavy elements is much too high. Hoyle shows that the data are more consistent with the view that, at the time of condensation of the stars, 99 per cent, and probably more than this, must have been in the form of hydrogen, the remainder consisting of heavy elements. The mean molecular weight of a star at the time of condensation must have been about 0·5, and a subsequent increase in this could arise only by the conversion of hydrogen into helium by thermonuclear reactions. In the case of small stars like the sun, very little change in composition has taken place during their life-times, so that the sun would now consist almost entirely of hydrogen. This constitution differs so widely from that of the earth, which contains very little hydrogen, that it is impossible to accept the view (now somewhat discredited) that the earth and other planets once formed part of the sun. The high ratio of hydrogen to metals in interstellar matter, obtained in 1939 by Dunham, is, Hoyle points out, a powerful argument in favour of his supernova theory of the origin of the solar system, which was developed in *Mon. Not. Roy. Astro. Soc.*, **105**, 175 (1945), and of which a short account appeared in *Nature*, **157**, 881 (1946).

The Night Sky in December

New moon occurs on Dec. 12d. 12h. 53m., U.T., and full moon on Dec. 27d. 20h. 27m. The following conjunctions with the moon take place: Dec. 3d.

14h., Saturn 4° S.; Dec. 4d. 04h., Mars 3° S.; Dec. 11d. 11h., Mercury 2° N.; Dec. 14d. 20h., Venus 3° N.; Dec. 30d. 21h., Saturn 4° S.; Dec. 31d. 23h., Mars 2° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Jupiter on Dec. 15d. 02h., Mercury being 0·6° S. Mercury is a morning star throughout most of the month, rising at 6h. 04m., and 7h. 12m. at the beginning and middle of the month respectively; on Dec. 31 the planet rises 12m. after the sun. Venus, an evening star, is conspicuous in the western sky for some time after sunset as an object of stellar magnitude −3·4; about 0·9 of the illuminated portion of the apparent disk is visible during the month. Mars, in the constellation of Leo, can be seen throughout the greater portion of the night, rising at 22h. 23m., 21h. 52m., and 21h. 04m., at the beginning, middle and end of the month, respectively, and is easily recognized from its proximity to Regulus, from which it moves eastward during the month. Jupiter, in conjunction with the sun on Dec. 1, is unfavourably placed for observation until the end of the month, when it is a morning star rising about 1¾ hours before the sun. Saturn, in the constellation of Leo, is well placed for observation, rising at 21h. 46m., 20h. 50m., and 19h. 44m., at the beginning, middle and end of the month, respectively. Occultations of stars brighter than magnitude 6 are as follows: Dec. 2d. 04h. 53·2m., λ Canc. (*R*); Dec. 8d. 06h. 20·5m., *m.* Virg. (*R*); Dec. 25d. 23h. 40·2m., κ Taur. (*D*); Dec. 26d. 00h. 09·7m., υ Taur. (*D*). The times are given for Greenwich, and *D* and *R* refer to disappearance and reappearance, respectively. The Geminid meteors are active in the early part of the month; they have usually short paths and are not very bright. Winter solstice takes place on Dec. 22d. 17h.

Chemistry of Penicillin at the University of Oxford

Sir Robert Robinson writes: "In the very flattering notice published in *Nature* of November 22, p. 703, the statement is made that it was in my laboratory that the main facts of the constitution of penicillin were elucidated. This is incorrect, because many of the fundamental observations were made in the laboratory of the School of Pathology. I think a claim for 'Oxford' as a whole has been misunderstood as applying to the Dyson Perrins Laboratory. The collaboration between Drs. E. P. Abraham and E. Chain, Prof. W. Baker and myself was a close partnership, and contributions were made by both laboratories. In the summer of 1943, penicillamine was synthesized by Dr. and Mrs. J. W. Cornforth, working in the Dyson Perrins Laboratory, but independently, and in the early autumn and later, the attack developed in collaboration with other centres, especially the Imperial College of Science and Technology, in the remainder of 1943. The complex development cannot be easily summarized, but an attempt is made in Chapter 1 (*Science*, 105, No. 2739, 653; 1947) of the monograph in course of preparation."

Announcements

Dr. B. P. Dey, director of the Board of Industrial and Research Schemes in Presidency College, Madras, formerly professor of chemistry in that College, has been appointed director of the Indian institute of Science, Bangalore, in succession to Sir J. C. Ghosh, who is now director-general of industry and supply to the Government of India.

The following appointments in the University of Leeds have been announced: Dr. N. B. Slater, honorary curator of the Cecil Duncombe Observatory; Mr. J. Mars, lecturer in economics; Mr. D. Johnston, lecturer in metallurgy.

The following appointments in the University of Sheffield have been announced: H. Ferrari, lecturer in mining; Dr. W. Hume-Rothery, honorary lecturer in the Department of Metallurgy; Prof. H. N. Green, professor of pathology, granted the additional title of director of cancer research. The following resignations have been announced: G. E. Cooke, lecturer in civil engineering; Dr. H. McIlwain, lecturer in biochemistry.

The following Colonial Service appointments have been announced: J. S. Blacklock, to be agricultural officer, Sarawak; G. P. Blair, to be agricultural officer, Trinidad; M. H. Breese, to be entomologist, Nyasaland; A. J. P. Goodchild, to be entomologist, Gold Coast; J. L. Jollans, to be agricultural officer, Gold Coast; E. H. Nichols, to be agricultural officer, Sierra Leone/Gambia; W. A. Wright, to be agricultural officer, Sierra Leone/Gambia; G. E. Crichton, to be assistant conservator of forests, Sierra Leone/Gambia; Capt. P. B. Finn, to be staff surveyor, Kenya; J. B. Lyle, to be superintendent of surveys, Palestine; E. F. Martin (deputy director of agriculture, Uganda), to be deputy director of agriculture, Kenya; L. D. E. F. Vesey-Fitzgerald (entomologist, Nigeria), to be senior assistant game warden, Kenya.

A new abstract journal, described as "a monthly service of information about developments in technology and research for business men, investors, the Press, educationists and suppliers of services to industry", has appeared under the title *Facts for Industry* (A. E. Blake, Lower North Dean, Hughenden, High Wycombe, Bucks. Annual subscription, 2 guineas). Abstracts vary in length from about fifty to five hundred words, and are classified by subjects; references to original papers are quoted. The October issue consists of twelve pages including thirty-eight abstracts.

The Hungarian Academy of Sciences has started issuing the following new scientific periodicals, the papers in which are all published in English, French or German: *Hungarica Acta Mathematica*, *Hungarica Acta Physica*, *Hungarica Acta Chimica*, *Hungarica Acta Physiologica*, *Hungarica Acta Biologica*, *Hungarica Acta Medica*. Each volume consists of six fascicles of about 15–17 sheets, and the price has been fixed at 35*s.* (7 dollars, or 30 Swiss francs) per volume. The Academy would welcome the exchange of publications with other scientific institutions, in connexion with which communications should be sent to the office of the Academy, Budapest V, Akadémia-utca 2.

The Prix Arnold Reymond, provided by the Fondation Charles-Eugène Guye, is offered by the University of Lausanne for a memoir on the tendencies of scientific philosophy during the preceding ten years. The award is made at intervals of between five and ten years, the first award having been made in 1944 to Dr. Pierre Lecomte du Noüy. Memoirs to be considered for the next award, which will amount to at least 1,000 Swiss francs, must reach the Commission du Prix Arnold Reymond, Fondation Charles-Eugène Guye, Sécrétariat de l'Université, Lausanne, by January 1, 1951.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Blackett's Fundamental Theory of the Earth's Magnetic Field

Soon after the publication of Prof. P. M. S. Blackett's paper[1], Dr. E. C. Bullard suggested to us that it should be possible to test Blackett's theory against other theories by measurements of the magnetic field of the earth in the mines of the Witwatersrand. By courtesy of the management of the Blyvooruitzicht G.M. Co., we made a series of underground observations on Blyvooruitzicht mine.

Using an Askania horizontal magnetometer (Schmidt type), we measured ΔH at five points underground on three successive days, giving in all fifteen determinations of ΔH. A similar instrument was read at the surface at 5-min. intervals during the duration of the underground measurements, so that we were able to allow for diurnal variation. The observations were not as satisfactory as we had hoped, in that there was a larger closing difference than we had expected when the underground instrument was brought back to the surface base station after the observations underground. This difference amounted to 14, 22 and 32 gamma on the three separate days.

The observations were referred to the mean of the values found at four points on an east–west line of 300 yd. centred above the points at which the underground observations were made. The closing error was allowed for in two ways: (1) it was assumed that it was due to random errors of reading, and ΔH was calculated from the mean of the initial and final surface readings; (2) it was assumed that the closing difference was due to a drift linear in time.

The final results for the full fifteen sets of observations with their standard deviations are:

H (underground) $-$ H (surface) $= -26 \pm 4\gamma$, corrected according to (1), and
H (underground) $-$ H (surface) $= -24 \pm 4\gamma$, corrected according to (2).

For the three days separately, these results were:

-31 ± 9, -21 ± 4 and -25 ± 2, corrected according to (1); and
-30 ± 10, -19 ± 4 and -23 ± 1, corrected according to (2).

The mean depth of the observation points below the mean surface for a distance of five miles from the observation point was 4,800 ft.

In a private communication (to be published), S. K. Runcorn compares the variation of the field with depth for Blackett's theory and for all theories which attribute the magnetism to processes in the central core of the earth. He obtains the formula:

$$\text{Blackett's theory: } H_d = H_0 \left\{1 - 2\left(\frac{5\rho_1}{\rho} + 1\right)\frac{d}{a}\right\};$$

$$\text{Core theories: } H_d = H_0 \left(1 + 3\,\frac{d}{a}\right);$$

where H_0 is H at surface, H_d is H at depth d, a is radius of the earth, ρ_1 is mean density of rocks to depth d, and ρ is mean density of the earth. From these formulæ, for a depth of 4,800 ft., we calculate

$$\Delta H = -26\,\gamma \text{ (Blackett's theory)};$$
$$\Delta H = +11\,\gamma \text{ (Core theory)}.$$

Before comparing the theoretical and observed effects, it is necessary to point out that the lower Witwatersrand system which underlies the underground observation point contains several shale bands which produce considerable anomalies at the surface (Krahmann[2]). Calculations based on Krahmann's values show that the shales produce a relative decrease at depth of not more than 9 γ. In addition, there were two dykes in the neighbourhood of the observation area which can be expected to give a relative decrease of not more than 5 γ. The effect of the local geological structure is thus to produce a decrease of at most 14 γ, and it might be as little as 6 γ. Allowing for the geological effects:

(1) H (underground) $-$ H (surface) $= -12 \pm 4$, or $-20 \pm 4\gamma$;
(2) H (underground) $-$ H (surface) $= -10 \pm 4$, or $-18 \pm 4\gamma$.

Even taking our lower limit, the results differ significantly from the core theory. They also differ significantly from the values calculated on the basis of Runcorn's formula. This difference may be accounted for by the fact that Runcorn's formula applies strictly to depth below the mean surface of the whole earth, whereas the mean surface level at Blyvooruitzicht is 5,200 ft. above mean sea-level. It is also possible that there is some geological factor of which we have not taken account. The uncertainty arising from local geological structure should be eliminated by an extended series of observations together with a detailed surface survey, which it is intended to carry out.

In addition to the management and staff of the Blyvooruitzicht G.M. Co., we are indebted to the director, Geological Survey Office, for the loan of instruments.

A. L. Hales
Bernard Price Institute of Geophysical Research,
University of the Witwatersrand,
Johannesburg.

D. I. Gough
Council for Scientific and Industrial Research,
Pretoria.

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[1] Blackett, P. M. S., *Nature*, 159, 658 (1947).

[2] Krahmann, R., *Trans. Geol. Soc., S. Africa*, 39, 1 (1936).

Universal Constants in Blackett's Formula

Recently, Blackett[1] has suggested that the formula

$$P = \beta \,.\, \frac{G^{1/2}U}{c}$$

represents a fundamental relation between the angular momentum U and the magnetic moment P of a massive rotating body; where G is the gravitational constant, c the velocity of the light and β a dimensionless constant of the order of unity. If the formula were true, it would be a great aid towards finding a theory unifying the gravitational and the electromagnetic field. It is, therefore, interesting to investigate what conditions the formula would impose upon such a future theory. If we assume that the equations of the new theory can be derived from a Lagrangian, and that the magnetic moment of a rotating body is originated through some cross-terms between the gravitational and the electromagnetic field quantities in the Lagrangian, then it would be found that there must be other universal constants than G and c in the theory.

Generally, the building materials available for forming a Lagrangian in a unified field theory are the various field quantities and the various universal constants. As building operations, there are summation, multiplication, squaring, taking roots, etc. Before commencing each step of summation it must be ensured that the different terms of the sum have the same dimensions. This is the step at which the universal constants enter into the theory. For example, the electromagnetic interaction is generally introduced by replacing the operator $\partial/\partial x^\mu$ by the following sum of operators

$$\frac{\partial}{\partial x^\mu} - \frac{i}{e} A_\mu,$$

where A_μ is the electromagnetic four-potential. In order to make the two terms of the same dimensions, it is necessary to introduce a constant e of the dimensions of charge.

In general, three 'linearly independent' universal constants would enable us to meet any such situation. From three such constants, numerical factors of any dimensions can be formed to ensure the uniqueness of the dimensions of the different terms in a sum. Even in the pioneering attempt of Weyl[2] to unify the gravitational and the electromagnetic field, a constant of the dimensions of charge was implicitly introduced besides G and c. It was introduced when he generalized Christoffel's three index symbols by replacing the operator $\partial/\partial x^\mu$ by the sum

$$\frac{\partial}{\partial x^\mu} + \varphi_\mu,$$

where φ_μ is connected with A_μ through this new constant. It seems that three universal constants would be the minimum number needed in building a unified field theory. If there were only the two constants, G and c, available, the possibilities of building a Lagrangian would be severely limited. Only those combinations of field quantities, the dimensions of which are different from each other by a factor $G^p c^q$, can be used to form a sum where p and q are any rational numbers. On the cross-terms, which are supposed to cause the magnetic moment of a rotating body, the following conditions are then imposed:

(*a*) One condition to ensure that the cross-terms are invariant with respect to co-ordinate transformations. This condition does not depend upon the number of universal constants.

(*b*) Three conditions to ensure that the cross-terms have the dimension cm.$^{-2}$ in the gravitational unit.

(*c*) Three conditions to ensure that the magnetic moment has a dependence on G, c and ρ as given by Blackett's formula, where ρ is the invariant density of the rotating body.

Detailed investigation shows that there exists only a very limited number of cross-terms of different structures which satisfy all the above conditions. Further, none of these cross-terms gives a satisfactory result. If the metric tensor of the gravitational field were not introduced into the cross-terms, the only possible cross-term has the form

$$\frac{G^{3/2}}{c^4} \rho A_\mu u^\mu.$$

u^μ is here the four-velocity of the element of matter. This would give the earth an electrostatic field which is large in comparison with its magnetic field. The metric tensor caused by a rotating body has been given by Lense and Thirring[3] in the first approximation. The non-vanishing, non-diagonal elements have the form

$$\sim \frac{G\,U}{c^3 R^2},$$

where R is the distance from the centre of the rotating body to the point of observation. If this tensor were introduced into the cross-terms, the resulting theory would give a wrong dependence on the angular velocity of the rotating body.

To free the new theory from some of the above conditions, universal constants other than G and c must be introduced. Since such constants must be in Blackett's formula, they must be contained in the factor β. To make β dimensionless, two constants other than G and c are required, unless we are prepared to introduce a constant of the dimension of $G^p c^q$. Generally, the introduction of universal constants is based on physical principles. The principle of the conservation of charge might be used to introduce one constant. However, it is difficult to imagine what is the other principle which can introduce the other constant. It appears, therefore, that some new physical principle lies behind Blackett's formula.

I wish to express my thanks to Prof. L. Rosenfeld for his most valuable advice. I also wish to thank Prof. P. M. S. Blackett for his kind encouragement and Mr. J. Hamilton for stimulating discussions.

H. Y. Tzu

The University,
Manchester.
Nov. 10.

[1] Blackett, P. M. S., *Nature*, 159, 658 (1947).
[2] Weyl, H., "Raum, Zeit und Materie" (4th edit., 1921).
[3] Lense, J., and Thirring, H., *Phys. Z.*, 19, 156 (1918).

Penetration of Magnetic Field into Superconductors

We have repeated Casimir's experiment[1] designed to measure the variation with temperature of the penetration depth (λ) of a magnetic field into a massive superconductor. The principle of the experiment is to measure at various temperatures the mutual inductance of two coils wound on a superconducting core; if the magnetic field of the primary coil penetrates slightly into the superconductor, the flux linkage with the secondary coil, and hence the mutual inductance, is slightly greater than if there were no penetration. A small decrease of mutual inductance should therefore be observed as the temperature, and with it, λ, is reduced.

Our experimental arrangement was very similar to that used by Casimir; 75 cycles/sec. A.C. was used in the bridge, and with a measuring current in the primary which produced a peak magnetic field of 0·5 gauss, it was possible to detect changes as small as 0·01 μH, so that the expected effect of order 0·5 μH could be measured with a few per cent accuracy. In his original experiment Casimir found no appreciable effect for mercury; but, as he has kindly informed us, it is likely that this was because the mutual inductance was mounted on an evacuated quartz tube containing the mercury; as the vapour pressure of the helium bath was lowered to reduce the temperature, the tube would have expanded slightly and thus produced a compensating decrease of mutual inductance. This possibility was avoided in our experiment by leaving the quartz tube open, and the expected increase of mutual inductance was found for both mercury and tin.

Unambiguous results were obtained with a freshly machined tin cylinder and a slowly frozen mercury cylinder, in each case cooled through the transition temperature with the earth's magnetic field compensated. In these circumstances the change of mutual inductance was unaccompanied by any appreciable out-of-phase component. We confirmed Casimir's observation that if the earth's field was uncompensated the change of mutual inductance was greater, but accompanied by a temperature-dependent out-of-phase component; this was probably due to a slight locking-in of flux across the cylinder, which left some resistive patches of normal metal at the surface, of an area inversely proportional to the critical field. We found also that if the tin had been exposed to air for some weeks or was rough, temperature-dependent resistive losses again appeared; and, moreover, the results became sensitive to the strength of the alternating magnetic field of the measuring current.

For tin the variation of $\Delta\lambda = \lambda(T) - \lambda$ (2·1° K.), deduced from the observed change of mutual inductance, with ΔT, the temperature difference from the transition temperature, is shown in Fig. 1. We have plotted also the points obtained by Pippard[2] using a radio-frequency method and by Désirant and Shoenberg (unpublished) from magnetic measurements of tin-filled capillaries; it will be seen that there is fair agreement. For mercury, different results were obtained with two different specimens, but in both cases the values of $\Delta\lambda$ are, within the limits of experimental error, proportional to those obtained by Désirant and Shoenberg[3] from magnetic measurements of bundles of mercury-filled capillaries (Fig. 2). Now Ginsburg[4] has pointed out that the penetration depth could depend on the direction of current-flow relative to the crystal axes, and such anisotropy may well be the cause of the discrepancy. It is, in fact, likely that the two mercury specimens were both single crystals or nearly so, but with different crystal orientations; so that the effective penetration depth would have been different in the two specimens. In the experiments of Désirant and Shoenberg, even if the individual cylinders had been single crystals, the large number of capillaries would have averaged out any directional effects and given a result characteristic of a polycrystal. The agreement between the present results and those of Pippard for tin is also plausible, since in both cases it is probable that the surface was polycrystalline; the slight differences may be due to slightly different preferred orientations. The fact that for mercury it is only the scale of the $\Delta\lambda - \Delta T$ curve which depends on crystal orientation is reasonable, for in terms of the London theory[5] it would mean that the effective mass of the superconducting electrons varied with the current direction in a crystal, but the ratio of masses in different directions did not vary with temperature (we have to thank Dr. H. London for this observation).

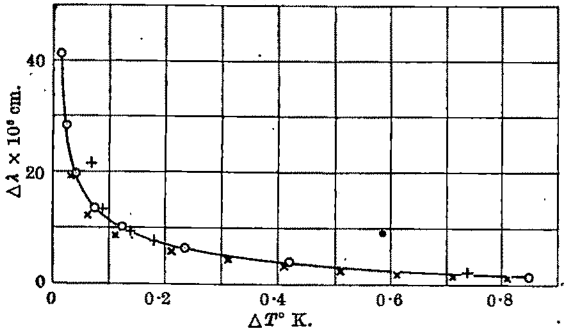

Fig. 1. RESULTS FOR TIN

o—o—o Present results, T_c = 3·711° K.
+ Désirant and Shoenberg, T_c = 3·738° K.
× Pippard, T_c = 3·711° K.

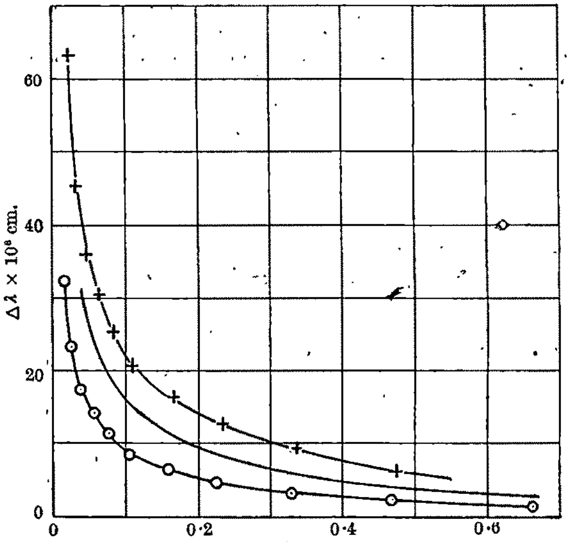

Fig. 2. RESULTS FOR MERCURY

o—o—o Present results (a), T_c = 4·158° K.
———— Désirant and Shoenberg, T_c = 4·17° K.
+—+—+ Present results (b), T_c = 4·165° K.

A few experiments were made to see whether there was any evidence for variation of penetration depth with magnetic field, an effect also predicted by Ginsburg[6]. A steady field was superimposed on the small alternating measuring field, but produced no appreciable effect up to about 0·5 of the critical field. For higher fields an apparent rise of penetration depth was obtained which eventually became very great, but since it was accompanied by a rapidly increasing out-of-phase component in the mutual inductance, it is not possible to obtain any definite interpretation; a genuine increase of penetration depth in this region of an amount comparable to the changes with temperature is certainly not excluded.

The experiments are being continued with the aim of obtaining precise data on the anisotropic effects, and to investigate the field dependence of λ.

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Radiations from Uranium (239) and Neptunium (239)

IN a recent communication[1] Slätis has reported on experiments on the β- and γ-radiations from $^{239}_{92}$U and $^{239}_{93}$Np, using magnetic analysis and absorption methods for the two types of radiation respectively.

For $^{239}_{92}$U the nuclear γ-radiation of 76 ± 3 keV. energy, first reported by Feather and Krishnan[2], has been confirmed, and its energy fixed as 73·2 ± 0·3 keV. by measurements on the line spectrum of L- and M-photo-electrons. Also, there is satisfactory agreement between the new value for the energy-limit of the main β-spectrum (1·12 MeV.) and the value (1·20 ± 0·02 MeV.) deduced from the absorption curve. But a serious discrepancy is evident between the conclusions indicated by the level scheme of Fig. 2 of Slätis's paper and the earlier results. The level scheme in question indicates that a γ-radiation of energy 870 keV. is emitted in cascade with the 73 keV. transition. Now it would appear that the only evidence for the assumption that a quantum of 870 keV. radiation is emitted in nearly every disintegration (as distinct from occasionally) is in the results of the analysis of the continuous β-spectrum by the Fermi method. This analysis is reported to yield a second high-energy component of feeble intensity and limiting energy 2·06 MeV. No such component was detected by the absorption method (it would have been a simple matter to have detected a high-energy component of intensity 0·05 in this way); furthermore, the published results of Feather and Krishnan set an upper limit of about the same magnitude (0·05) to the emission probability of a possible 870 keV. quantum.

We also observed a second γ-radiation, and estimated its intensity at about 0·10 per disintegration on the assumption that the quantum energy was of the order of 300–600 keV. If the energy were assumed to be twice as great, the calculated intensity would be roughly halved. It would seem, therefore, that the level scheme of Slätis's Fig. 2 cannot be substantiated, and that the total disintegration energy of $^{239}_{92}$U is 1·20 ± 0 05 MeV., not 2·06 MeV. The β-spectrum which was observed to have the latter energy limit must, in this case, have another origin.

As regards $^{239}_{93}$Np, it is interesting to compare the results of the Fermi analysis of Slätis with unpublished results which I obtained by the absorption method early in 1941[3]. Analysing the complete absorption curve of the β- and γ-radiation by standard methods[4], it was then concluded that the β-radiation of $^{239}_{93}$Np was constituted as follows:

	Energy (keV.)	Intensity
Photo-electrons	—	~ 0·6
Partial spectrum 1	140 ± 25	~ 0·2
" " 2	400 ± 20	0·7
" " 3	630 ± 20	0·1
" " 4	> 1000	< 0·05

Slätis's analysis leads to maximum energies of 288, 403, 676 and 1,179 keV., and, as concerns intensities, the preliminary report merely indicates that the second partial spectrum with end-point at 403 keV. is the most intense.

The general similarity of the results is not without significance, particularly in relation to the claim that, under suitable control, the absorption method can be of real use in the analysis of complex β-spectra, so long as sufficiently detailed observations are made. It might be mentioned in this connexion that the absorption measurements on the β-radiation of $^{239}_{93}$Np were made using sources of less than 10^{-4} mC. strength obtained from the decay of $^{239}_{92}$U produced by the (d, p) reaction with uranium on the Cambridge cyclotron. Chemical separations were made under the direction of Dr. E. Bretscher, to whom belated thanks are now recorded.

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Autoradiograph Technique

EXPERIMENTS aiming at an improvement of the resolution obtained with the autoradiograph technique were recently carried out, and a short outline of the methods used is given here.

15 μC. of radioactive iodine (I^{131}) were injected subcutaneously into a rat (wt. 125 gm.). The thyroid was fixed in alcohol and sections 5 μ thick were cut after embedding in paraffin. Fig. 1 shows a photomicrograph of a stained section of the thyroid. After dissolving the paraffin, sections were brought into contact with the photographic film or plate, and the two pressed together in a printing frame and left there for a suitable time of exposure. The sections were not coated with 'Colloidin' before exposure. The film or plate was then developed and fixed[1,2]. Of the various emulsions tried, Ilford Line film showed the best resolution. Fig. 2 shows an autoradiograph made from the section shown in Fig. 1 before staining, the well-known fact that iodine is concentrated in the colloid of the thyroid follicles appearing clearly in the autoradiograph. Colloid particles 10 μ apart can still be distinguished as separate units; if the distance is 15 μ the separation is very clear. The exposure is about twenty times that needed for a fast X-ray film.

In order to improve resolution, stripping emulsion was removed from its base and immersed in water. A slide carrying a section was placed underneath the emulsion, both lifted out of the water and dried quickly in front of a fan. The slides were then left

Fig. 1

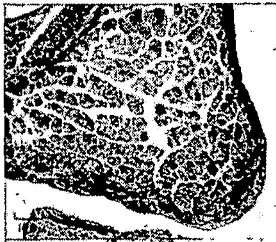
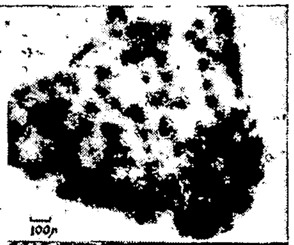


Fig. 2



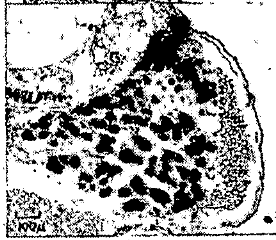


Fig. 3

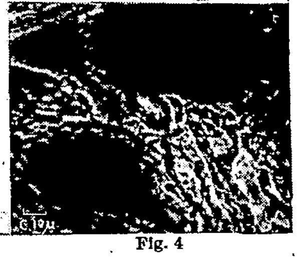


Fig. 4

in a light-proof container and developed and fixed after a suitable interval. The original section and the autoradiograph are superimposed and can be viewed simultaneously. Fig. 3 shows a photomicrograph, and the improved resolution can be judged by comparison with Fig. 2. Determination of the location of the radioactive substance will be facilitated as both cells and autoradiograph can be viewed simultaneously. Methods of staining through the covering layer of gelatine were tried but have so far been unsuccessful. A photomicrograph taken with the phase-contrast microscope (Fig. 4) depicts the ring of cells around the colloid with sufficient detail for judging the location of the radioactive material. The resolution of the autoradiograph can also be judged from this illustration.

Ilford half-tone, thin film, dry stripping emulsion was found very suitable. The exposure is about four times that needed for a fast X-ray film. Specially prepared slides which prevent lifting off of the emulsion during processing were supplied by Kodak, Ltd.

I wish to thank Dr. I. Doniach, of the British Postgraduate Medical School, for the histological work done; Dr. A. F. W. Hughes, of the Strangeways Laboratory, Cambridge, for preparing the photomicrograph Fig. 4; and Mr. C. Waller, of Messrs. Ilford, Ltd., and Dr. R. H. Herz, of Messrs. Kodak, Ltd., for much helpful discussion.

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Entropy Fluctuations in Liquid Helium II and the Rayleigh Line

It is known[1] that in the scattered light spectra of liquids the Rayleigh line exhibits an undisplaced component of the same frequency as the exciting light and two displaced components on either side of the undisplaced line. It was shown by Landau and Placzek[2] that the intensity I_u of the undisplaced component and the sum of the intensities $2I_v$ of the displaced components is given by

$$\frac{I_u}{2I_v} = \frac{C_p - C_v}{C_v},$$

where C_p and C_v are the specific heats at constant pressure and constant volume respectively. The Landau – Placzek relation accords with experiment reasonably well for several liquids. Recently, Gross[3] has given an interesting derivation of the Landau–Placzek relation. He has shown that the undisplaced component is caused by entropy fluctuations, and the displaced components arise on account of the density fluctuations. The density fluctuations, constituting as they do the Debye elastic-vibrations, travel in a liquid with the velocity of the Debye-waves. The entropy fluctuations, on the other hand, can be regarded as stationary, and hence give rise to the undisplaced component.

The present note is concerned with an application of the theory of Landau and Placzek, and Gross, to liquid helium II. As has been shown by Landau[4] in liquid helium II we have to deal with two velocities of sound waves, a result which has been confirmed by the experiments of Peshkov[5]. One wave is the normal one, that is, due to density fluctuations, and the second sound wave is due to entropy fluctuations. In liquid helium II, the entropy fluctuations are no longer stationary but travel with a velocity which is zero at the λ-point, increases with increasing temperature (T) and approaches the value $C_1/\sqrt{3}$ as $T \rightarrow 0$, where C_1 is the velocity of the density waves (normal sound). It therefore follows that the Rayleigh line in liquid helium II should show a structure radically different from that in other liquids. Instead of the undisplaced component and the two displaced components there should arise (as $T \rightarrow 0$) four displaced components and no undisplaced component. The experimental observation of the scattering of liquid helium II, if accomplished, will throw an interesting light on the existence of normal and super-fluid liquid in helium II.

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Third-Order Elastic Coefficients of Crystals

It is well known that the number of independent second-order elastic coefficients required to describe the behaviour of cubic crystals is three, irrespective of the class to which they belong, whereas the corresponding number for isotropic bodies is two. That a crystal of the cubic system differs from an isotropic body in another important respect, namely, its photo-elastic behaviour, was discovered by Pockels. Pockels, however, as in the case of elasticity, made no distinction between the five classes of crystals coming under the cubic system, but assigned three coefficients only for all of them. Contrary to this, one of us[1] showed, by a different method based on group theory, that the T and T_h classes of the cubic system require four coefficients for the description of their photo-elastic behaviour, whereas the other three classes T_d, O and O_h require only three. This prediction has been verified by us experimentally by working with crystals of potassium alum[2].

Recent work of Francis Birch[3] on the theory of finite strain is of interest in this connexion because he has reported that the number of third-order coefficients required to describe the behaviour of cubic crystals is eight for the T, T_h and T_d classes and six for the O and O_h classes. Birch has shown that the maximum number of such coefficients permissible in a triclinic crystal is 56. The method developed by us is of such wide applicability that the numbers of coefficients required to describe any physical property can be easily calculated for all the crystal classes, and this has been done in papers published elsewhere[4].

We have now extended this method to the case of finite strain. The notation used is the same as that adopted in our earlier papers. The character of the matrix relating to the transformation of the 56 coefficients under a general symmetry operation consisting either of a rotation through φ or of a rotation through φ accompanied by a reflexion works out to be

$64\cos^6\varphi \pm 32\cos^5\varphi - 48\cos^4\varphi \mp 8\cos^3\varphi + 16\cos^2\varphi$. Where alternatives occur, the upper or the lower sign should be used respectively for rotation and a rotation reflexion. Using this character and the general formula derived in the earlier papers, the numbers of coefficients for each class are obtained as 56 for C_1 and C_i; 32 for C_s, C_2 and C_{2h}; 20 for C_{2v}, D_2 and D_{2h}; 16 for C_4, S_4 and C_{4h}; 12 for C_{4v}, D_{2d}, D_4 and D_{4h}; 20 for C_3 and S_6; 14 for C_{3v}, D_3 and D_{3d}; 12 for C_{3h}, C_6 and C_{6h}; 10 for D_{3h}, C_{6v}, D_6 and D_{6h}; 8 for T and T_h; 6 for T_d, O and O_h.

These results show that there is a distinction, as in the case of photo-elasticity, between the T and T_h classes of the cubic system on one hand and the T_d, O and O_h classes on the other. They confirm the findings of Francis Birch in all respects except in the T_d class, for which he states that eight coefficients are required. This is presumably due to his not having taken into account a four-fold rotation reflexion axis which this class possesses.

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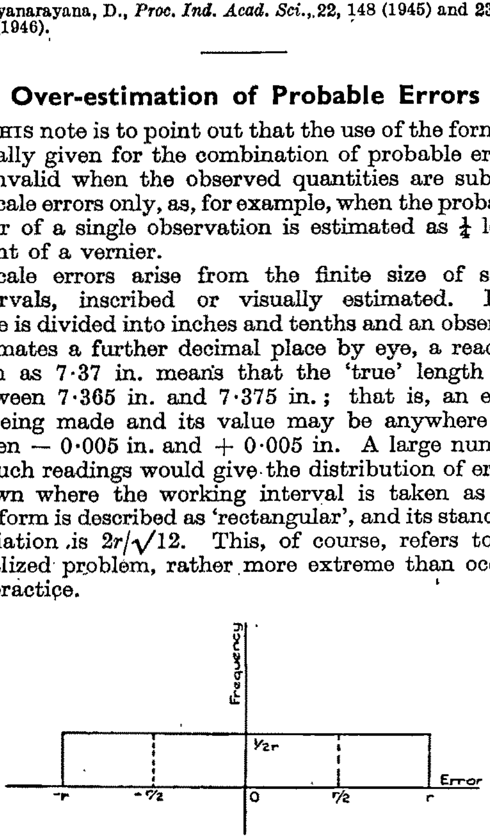
Over-estimation of Probable Errors

This note is to point out that the use of the formula usually given for the combination of probable errors is invalid when the observed quantities are subject to scale errors only, as, for example, when the probable error of a single observation is estimated as ¼ least count of a vernier.

Scale errors arise from the finite size of scale intervals, inscribed or visually estimated. If a scale is divided into inches and tenths and an observer estimates a further decimal place by eye, a reading such as 7·37 in. means that the 'true' length lies between 7·365 in. and 7·375 in.; that is, an error is being made and its value may be anywhere between − 0·005 in. and + 0·005 in. A large number of such readings would give the distribution of errors shown where the working interval is taken as $2r$; the form is described as 'rectangular', and its standard deviation is $2r/\sqrt{12}$. This, of course, refers to an idealized problem, rather more extreme than occurs in practice.



The 'probable error' is defined as the value of the deviation beyond which half the observations lie; in the case of the rectangular distribution it is $r/2$; the probable error of a reading of a vernier scale with least count 0·01 in. is 0·0025 in. (On the other hand, if repeated observations of a quantity give a standard deviation of σ, and the errors are assumed normally distributed, the probable error of a single observation is $0{\cdot}6745\sigma$.)

Let z be a linear function of $u, v, w \ldots$, say, $z = au + bv + cw + \ldots$, then the error in z due to errors in $u, v, w, \ldots$ is

$$p^2 = a^2p_1^2 + b^2p_2^2 + \ldots, \tag{1}$$

where p is probable error of z, p_1 that of u, p_2 that of v, etc. This rule is valid for normal distribution of errors in $u, v, w, \ldots$; but errors following a rectangular distribution cannot be combined in this way because the error of a linear function of a number of such variables has not itself a rectangular distribution. Hence its probable error forms a different fraction of the range, or more correctly, of the standard deviation. The difficulty arises because the probable error depends on the form of the distribution, and no simple method exists for combining probable errors of different types of distribution. It is quite different with the standard deviation, which measures the dispersion of the distribution, and combines by a simple rule for very general forms of the component distributions[1]. Thus, if $\sigma, \sigma_1, \sigma_2, \ldots$ are standard deviations of $z, u, v, \ldots$ respectively, then

$$\sigma^2 = a^2\sigma_1^2 + b^2\sigma_2^2 + c^2\sigma_3^2 + \ldots \tag{2}$$

This equation readily yields (1) when errors in $u, v, w, \ldots$ are distributed normally. On the contrary, if errors in $u, v, w, \ldots$ are scale errors only, estimated from working intervals $2r_1, 2r_2, 2r_3, \ldots$, the respective standard deviations are $2r_1/\sqrt{12}$, $2r_2/\sqrt{12}$, $2r_3/\sqrt{12}, \ldots$ and (2) gives

$$\sigma^2 = \tfrac{1}{3}(a^2r_1^2 + b^2r_2^2 + c^2r_3^2 + \ldots). \tag{3}$$

It is known that the distribution of the sum of a number of rectangularly distributed variables tends to normality[2] fairly rapidly as the number increases, so that σ will be the standard deviation of a nearly normal distribution, in which case $p \doteqdot 0{\cdot}6745\sigma$. Applied in the same problem, (1) would have yielded

$$\begin{aligned} p^2 &= a^2(\tfrac{1}{2}r_1)^2 + b^2(\tfrac{1}{2}r_2)^2 + c^2(\tfrac{1}{2}r_3)^2 + \ldots \\ &= \tfrac{3}{4}\sigma^2, \text{ or } p = 0{\cdot}8660\sigma. \end{aligned} \tag{4}$$

This represents an over-estimation by 28 per cent on the value obtained from (3), but, as will be shown below, the latter is itself slightly in defect.

The only treatment of errors of interval to my knowledge is that given by Gibbs[3], where approximations are obtained for the probable error of z with $a, b, c, \ldots$ restricted to the values + 1 and $2r_1 = 2r_2 = 2r_3 = \ldots 1$; the method over-estimates p. An exact treatment may be based on the cumulated probability function for the sum of n rectangular variables

$$\frac{1}{n!}\sum_{x \geqslant j}(-1)^j\binom{n}{j}(x-j)^n. \tag{5}$$

It is of interest to compare the approximations based on (3), and the fallacious values obtained from (1), with the exact probable errors based on (5) (probable errors given in terms of interval).

No. of variables (n) =	1	2	3	4	5	6	7
Method of estimation of probable error:							
Exact (5)	0·250	0·293	0·353	0·403	0·447	0·487	0·525
Normal (3)	0·195	0·276	0·337	0·390	0·435	0·477	0·515
Fallacious (1)	0·250	0·353	0·433	0·500	0·559	0·612	0·661
Under-estimation by (3), per cent	22·0	6·2	4·7	3·2	2·8	2·1	1·9
Over-estimation by (1), per cent	0	20·5	22·7	24·1	25·1	25·7	25·9

When more than three errors are combined by method (3), the departure from the correct estimate is so slight that it can be ignored; but the over-estimation by formula (1) is serious in all cases.

The essential point is this. If the probable error of a variable directly measured is calculated from the standard deviation of repeated measurements (assumed normally distributed), equation (1) may be used to calculate the probable error of a linear function of such variables. On the other hand, if the direct measurements are not repeated but have their probable errors estimated from the working intervals, equation (1) will over-estimate the probable error of the calculated result.

When the magnitude of the scale error differs among the variables, formula (5) must be modified, and the resultant probable error depends on the relative magnitudes of the scale errors. The net result is that equation (3) will not be far out when the scale errors are of about the same magnitude; but when they differ widely, the largest dominates the precision of the result and the rest may be ignored.

It should be noted again that these difficulties arise only when experimenters use 'probable' errors, now generally discarded in applied statistics. It will be a welcome reform in the 'exact' sciences when standard deviations and standard errors are accepted as conventional.

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Relationship Between the Dissociation Constants of Unsymmetrical Dicarboxylic Acids

The correlation of the first and second dissociation constants of symmetrical dicarboxylic acids with the distance apart of the ionizing groups is well known. An experimentally convenient correlation has not previously been proposed for unsymmetrical acids. For symmetrical acids the relationship may be represented by the equation

$$\log_{10} \frac{K_a'}{\delta\, K_a''} = \frac{N_0\, \varepsilon^2}{2{\cdot}303\, RTD_E r},$$

where K_a' and K_a'' are respectively the first and second measured thermodynamic dissociation constants, δ is a symmetry number (in this case 4), N_0 the Avogadro number, ε the electronic charge, R the gas constant, T the absolute temperature and D_E the effective dielectric constant for the space between the two ionizing groups separated by the distance r. For unsymmetrical acids a solution of the problem may be obtained by the following considerations.

In the case of any unsymmetrical dicarboxylic acid HA_1A_2H we write

$$K_a^{\mathrm{I}} = \frac{a_{\mathrm{H}^+} \cdot [\mathrm{H}A_1A_2^-] \cdot f_-}{[\mathrm{H}A_1A_2\mathrm{H}] \cdot f_0} \text{ and } K_a^{\mathrm{II}} = \frac{a_{\mathrm{H}^+} \cdot [A_1A_2\mathrm{H}^-] \cdot f_-}{[\mathrm{H}A_1A_2\mathrm{H}] \cdot f_0}$$

for the thermodynamic dissociation constants corresponding to the two alternative steps for the first dissociation; and

$$K_a^{\mathrm{III}} = \frac{a_{\mathrm{H}^+} \cdot [A_1A_2^{=}] \cdot f_{=}}{[\mathrm{H}A_1A_2^-] \cdot f_-} \text{ and } K_a^{\mathrm{IV}} = \frac{a_{\mathrm{H}^+} \cdot [A_1A_2^{=}] \cdot f_{=}}{[A_1A_2\mathrm{H}^-] \cdot f_-}$$

for the corresponding two alternative routes for the second dissociation. In these expressions f_0, f_- and $f_=$ are the appropriate activity coefficients for the undissociated acid, for the monovalent anions and for the divalent anion respectively.

Now if the unsymmetrical acid be subjected to potentiometric titration we have, for the addition of B equivalents of strong base,

$$A = \text{molarity of the acid} = [\mathrm{H}A_1A_2\mathrm{H}] + [\mathrm{H}A_1A_2^-] + [A_1A_2\mathrm{H}^-] + [A_1A_2^{=}] \text{ and}$$
$$B + [\mathrm{H}^+] = [\mathrm{H}A_1A_2^-] + [A_1A_2\mathrm{H}^-] + 2[A_1A_2^{=}] + [\mathrm{OH}^-].$$

If we then define

$$\alpha = B + [\mathrm{H}^+] - [\mathrm{OH}^-] = [\mathrm{H}A_1A_2^-] + [A_1A_2\mathrm{H}^-] + 2[A_1A_2^{=}]$$
$$\beta = A - B - [\mathrm{H}^+] + [\mathrm{OH}^-] = [\mathrm{H}A_1A_2\mathrm{H}] - [A_1A_2^{=}]$$
$$\text{and } \gamma = 2A - B - [\mathrm{H}^+] + [\mathrm{OH}^-] = 2[\mathrm{H}A_1A_2\mathrm{H}] + [\mathrm{H}A_1A_2^-] + [A_1A_2\mathrm{H}^-]$$

it is readily shown that

$$a_{\mathrm{H}^+}^2 \cdot \left(\frac{\alpha}{\gamma}\right) \cdot \frac{f_=}{f_0} = (K_a^{\mathrm{I}} + K_a^{\mathrm{II}}) \cdot a_{\mathrm{H}^+} \cdot \left(\frac{\beta}{\gamma}\right) \cdot \frac{f_=}{f_-} + \frac{(K_a^{\mathrm{I}} + K_a^{\mathrm{II}})\,(K_a^{\mathrm{III}} \cdot K_a^{\mathrm{IV}})}{(K_a^{\mathrm{III}} + K_a^{\mathrm{IV}})}$$

The constant term in this equation may be simplified by the considerations that

$$K_a^{\mathrm{I}}/K_a^{\mathrm{IV}} = \exp N_0\varepsilon^2/RTD_E r \text{ and } K_a^{\mathrm{II}}/K_a^{\mathrm{III}} = \exp N_0\varepsilon^2/RTD_E r,$$

where the symbols have the significance previously employed. The equation then reduces to

$$a_{\mathrm{H}^+}^2 \cdot \left(\frac{\alpha}{\gamma}\right) \cdot \frac{f_=}{f_0} = (K_a^{\mathrm{I}} + K_a^{\mathrm{II}}) \cdot a_{\mathrm{H}^+} \cdot \left(\frac{\beta}{\gamma}\right) \cdot \frac{f_=}{f_-} + K_a^{\mathrm{I}}K_a^{\mathrm{II}} \cdot \exp - N_0\varepsilon^2/RTD_E r.$$

Clearly this may be plotted as a linear equation, and if either K_a^{I} or K_a^{II} be known, then the electrostatic term $\exp - N_0\varepsilon^2/RTD_E r$ may be evaluated and used for calculation of r. For this purpose it is only necessary to determine the dissociation constant of one of the mono-methyl esters, say, of the acid.

If $K_a^{\mathrm{I}} = K_a^{\mathrm{II}}$ and $K_a^{\mathrm{III}} = K_a^{\mathrm{IV}}$, that is, if the acid be symmetrical, it is readily shown that the equation reduces to a form which has been successfully employed by Speakman[1] for symmetrical dicarboxylic acids.

Application of the equation for unsymmetrical acids to problems in molecular structure will be reported elsewhere.

I thank Prof. H. V. A. Briscoe for his interest in these derivations.

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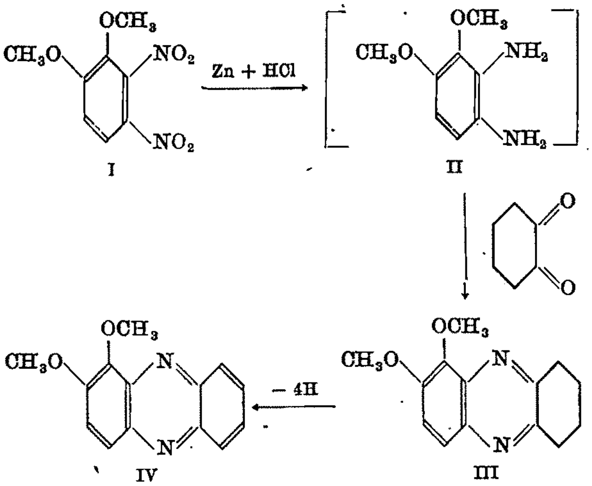
Aug. 8.

Speakman, J. C., *J. Chem. Soc.*, 855 (1940).

Phenazine Synthesis

Continuing the researches of Clemo and McIlwain[1] on the structure of the pigment of *Chromobacterium iodinum*, we are engaged in the synthesis of phenazines. In view of the recent communication of Slack and Slack[2], describing the preparation of 1 : 2-dimethoxyphenazine, we wish to put on record an independent synthesis using the method of Clemo and McIlwain[3].



An alcoholic solution of 3 : 4-dinitroveratrole[4] (I) was reduced by the action of zinc and hydrochloric acid, and the final solution of the reduction product was condensed with cyclohexane-1 : 2-dione[5], without attempting to isolate the pure free base (II). The resulting 1 : 2-dimethoxy-5 : 6 : 7 : 8-tetrahydrophenazine (III) crystallized from light petroleum (b.p. 40–60°) in straw-coloured needles, m.p. 82–83° (found : C, 69·0 ; H, 6·6. $C_{14}H_{16}O_2N_2$ requires C, 68·9 ; H, 6·6 per cent).

Dehydrogenation of (III) in *p*-cymene solution using palladium charcoal gave 1 : 2-dimethoxyphenazine[2] (IV), which crystallized from light petroleum, b.p. 80–100°, in orange-yellow blades, m.p. 138–139° (found: C, 70·0 ; H, 5·4. $C_{14}H_{12}O_2N_2$ requires C, 70·0 ; H, 5·0 per cent).

Attempts to prove the structure of the bacterial pigment by synthesis are in progress and a full account will be published elsewhere.

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[2] Slack, P. Z., and Slack, R., *Nature*, 160, 437 (1947).

[3] Clemo, G. R., and McIlwain, H., *J. Chem. Soc.*, 1991 (1934).

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Thermal Decomposition of Organic Nitrates

The kinetics and mechanism of the thermal decomposition of organic mono- and poly-nitrates have been studied during recent years by Bawn and Wiseman[1], A. J. B. Robertson[2] and more extensively by me[3]. Studies on the overall decomposition in liquid and vapour phases suggest strongly that fission of O—N bonds with formation of NO_2 is the primary process, while I have shown[3] that during the very early stages of decomposition of a wide range of organic nitrates, in which the occurrence of secondary reactions is prevented, nitrogen is eliminated from the molecule wholly as NO_2. These observations and the identification of aldehydes among the decomposition products indicate that, as suggested earlier by Bawn[1], the mechanism postulated by Appin *et al.*[4] for methyl nitrate applies to organic nitrates in general, namely :

$$RCH_2O - NO_2 \rightarrow RCH_2O^- + NO_2$$
$$RCH_2O^- \rightarrow \tfrac{1}{2}RCHO + \tfrac{1}{2}RCH_2OH,$$

followed by oxidation-reduction reactions between the products.

The pressure/time curves for the overall decomposition of a wide range of these nitrates conform to the first-order relationship over their greater part, but temperature-independent factors are usually abnormally high, ranging from $10^{14 \cdot 7}$ for *n*-propyl nitrate to $10^{20 \cdot 6}$ for mannitol hexanitrate, while apparent activation energies range from 34 to 47 kilo-cal./mole. The magnitude of these temperature-independent factors has aroused considerable speculation, particularly as to the possible incidence of chain reactions, but no satisfactory explanation has been found. Thus Roginski and Sapozhinkoff[5] showed that the rates of decomposition of nitroglycerine in the liquid state and in dilute solution were the same, and also that the usual chain-breakers are without effect ; I find[3] no large difference between decomposition-rates of other polynitrates in the vapour and liquid phases.

The placing of theoretical interpretations on such kinetic constants should, however, be approached with caution, since more than one reaction occurs during decomposition, particularly with polynitrates, the apparent order of reaction being controlled by the fission of O—N bonds, which is a first-order process.

It is improbable, however, that such considerations will account wholly for the abnormally high B factors. This is confirmed by my work on the very early stages of the decomposition of a range of organic nitrates, where secondary reactions are prevented[3]. Here the extent of the decomposition of polynitrates studied is so small that it is reasonable to assume that fission of only one O—N bond is involved. Typical results are shown in the accompanying table.

Nitrate	Temp. (°C.)	k
Ethylene glycol dinitrate	85–105	$10^{15 \cdot 9} \exp - 39000/RT$ sec.$^{-1}$
Trimethylene glycol dinitrate	85–110	$10^{15 \cdot 8} \exp - 38100/RT$ sec.$^{-1}$
Propylene glycol dinitrate	80–100	$10^{15 \cdot 2} \exp - 37400/RT$ sec.$^{-1}$
Nitroglycerine	75–105	$10^{17 \cdot 1} \exp - 40300/RT$ sec.$^{-1}$
Trimethylol-nitromethane trinitrate	75–95	$10^{15 \cdot 9} \exp - 36400/RT$ sec.$^{-1}$

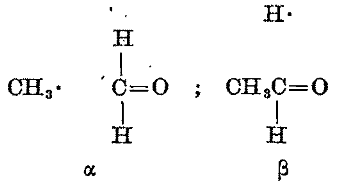
In general, temperature-independent factors are still higher than those normally associated with first-order reactions. The most probable explanation of this, since evidence so far does not support the postulation of long chains, is that appreciable positive entropies of activation due to restricted rotation about C—C bonds are associated with these reactions. Thus on the basis of the activated-complex theory[6], the 'temperature-independent' factor in the Arrhenius equation for a rapid first-order reaction is identified with the expression

$$e \cdot \frac{kT}{h} \cdot \exp \Delta S^{\ddagger}/R,$$

where $\Delta S^{\ddagger}$ is the entropy of activation. Construction of models of polynitrate molecules shows that in the position of closest approach, mutual dipolar repulsion of nitrate groups is probably large enough to set up an appreciable potential barrier to free rotation about

C—C bonds in the initial state. This view is to some extent supported by the results of de Kreux[7] on the dipole moments of organic nitrates. Such a barrier between two nitrate groups should largely disappear in the transition state when one O—N bond is broken, thereby resulting in an appreciable positive entropy of activation.

In the present work it has been shown that the order of stabilities of O—N bonds in the alkyl nitrates is methyl > ethyl > *n*-propyl. This can be explained on the basis of reduction of the O—N bond-energy by the extra resonance-energy of the RCH$_2$O— radical due to a hyperconjugation effect similar to that postulated by Polanyi and Butler[8] for the alkyl halides. Thus the CH_3CH_2O— radical has the extra resonance forms



$$\underset{\alpha}{CH_3\cdot \quad \overset{H}{\underset{H}{|}}\!\!C{=}O} \; ; \; \underset{\beta}{\overset{H\cdot}{}CH_3\underset{H}{C}{=}O} \quad \text{(twice)},$$

the α-form being more probable than the three extra resonance forms in the corresponding CH_3O— radical because of the difference between the C—C and C—H bond energies. Further structural effects observed by me, for example, the de-stabilizing effect of a second nitrate group and of electro-negative groups, can similarly be explained.

Details of this work, which was carried out during 1941–45, will be published elsewhere together with results of more work now in progress in this field.

This communication is published with the approval of the Chief Scientist, Ministry of Supply.

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Aug. 15.

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[2] Unpublished work (Scientific Advisory Council Reports).
[3] Unpublished work (C.R.D.D. Report, Ministry of Supply).
[4] *Acta Phys. Chem. U.S.S.R.*, 655 (1936).
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[8] *Trans. Farad. Soc.*, 39, 19 (1943).

Reduction of Aniline in Ammonia

IN a recent paper by Watt, Knowles and Morgan[1] on the course of reduction in liquid ammonia the following statement is made: "In view of the results reported by Wooster[2] it is surprising that reduction of nitrobenzene by the sodium-methanol combination yielded aniline and not dihydroaniline—". Unpublished work by me has shown that aniline is reduced by sodium and methanol in liquid ammonia, as would be expected by analogy with the reduction of dimethylaniline[3], which Watt, Knowles and Morgan do not mention. If the reduction is carried out rapidly, the product is a dihydroaniline, probably the 2 : 5-, since acid hydrolysis leads to *cyclo*hexenone. Slow reduction, however, gives chiefly a tetrahydroaniline, probably the 1 : 2 : 5 : 6- ; 3 : 5-dinitrobenzoyl derivative, m.p. 198° (found: C, 53·3; H, 4·6. $C_{13}H_{13}O_6N_3$ requires C, 53·6; H, 4·5 per cent). Its melting point is depressed by admixture with the derivative from aniline, m.p. 235°, and it cannot be an enamine since it is stable to mineral acid. There is little reduction of dimethylaniline past the dihydro-stage under the conditions used here, namely, excess of alcohol, so that the further reduction of dihydroaniline is probably due to isomerization of the enamine to the imine:

$$—CH{=}C(NH_2)— \rightarrow —CH_2C({=}NH)— ;$$

and reduction of the imino-group, rather than to conjugation of the nuclear bonds and reduction of the conjugated system. The latter reaction should lead in any event to an enamine, which would give on acid hydrolysis *cyclo*hexanone, as is, in fact, the case with dimethylaniline in the presence of excess sodium[3]. The facile rearrangement of enamines to imines probably explains the formation of, for example, tetrahydroquinoline rather than dihydroquinoline by reduction of quinoline with sodium and alcohol.

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Aug. 18.

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[1] *J. Amer. Chem. Soc.*, 69, 1657 (1947).
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White-eyed Mutants of Diptera

Two recent papers[1,2], as well as an older one[3], compare white-eyed mutants found in *Culex*, *Calliphora* and *Phormica*, respectively, with the white-eyed types long known in *Drosophila*. Since in no *Drosophila* species is more than one single-gene difference known that will give rise to a white eye, it is concluded that these types in other Diptera represent mutations corresponding to the white of *Drosophila*.

There is a special reason why this conclusion cannot be accepted. It has been known for some time that there are two distinct pigments, a red and a brown, in the eye of the wild-type *Drosophila*. The red pigment is absent in the brown mutant; the brown is absent in the vermilion, cinnabar and scarlet mutants; both are absent in white. The results of Becker[4] show that the red pigment is absent in *Calliphora*—in which, therefore, the wild type is like the brown mutant of *Drosophila*. This appears to be the usual condition in insects; the red pigment is apparently present in all Drosophilidæ that I have examined, but seems to be present in only a few of the related families. It should, therefore, not be possible to distinguish the white, vermilion, cinnabar and scarlet mutants in more remote families unless special methods are used.

There is available a method for further differentiation here, namely, the study of the hormones involved in eye-pigment production. As is well known, the white and scarlet mutant types of *Drosophila* are not affected by hormones; but there are two separate hormones involved in the production of the brown pigment, of which vermilion lacks one, cinnabar the other[5]. It has been shown that these hormones are not species-specific in their activity, and cross-tests with *Drosophila* have been made with mutant eye-colours in other insects. In this way it has been shown that the mutant 'ivory' (and its allele 'orange') in the hymenopteron *Habrobracon* is due to a deficiency in the hormone that is lacking in cinnabar *Drosophila*[6], and that there is a similar correspondence in two mutant types of Lepidoptera: the 'red' of *Ephestia* corresponds to vermilion[7], and the 'white-1' of *Bombyx* corresponds to cinnabar[8].

It will be noted that one of these types is in fact white, while another one is only slightly pigmented—as might be expected if a single eye-pigment is present.

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Excessive Hydration in an Animal with an Open Type of Circulation

A CONDITION of excessive hydration, with great distension of the body, has been observed in the aquatic crustacean *Asellus*, and is interesting since (1) the relatively rigid crustacean exoskeleton might have been expected to preclude such a condition, and (2) in the open type of circulation, of Crustacea, there is no barrier corresponding to the capillary wall which, in an animal with closed circulation, plays an important part in the etiology of the œdematous type of excess hydration, that is, distension of the tissue spaces with fluid[1].

The condition in *Asellus* has been observed very occasionally in Nature, not infrequently in laboratory stocks, and in 30 per cent of individuals undergoing regeneration of limbs in unfavourable external media. A similar condition develops, particularly in young individuals, during histological fixation. It has been induced experimentally by sealing the surface of the gills (respiratory pleopods) with 'Celloidin'.

The incipient condition affects the gills only, their exoskeleton being particularly thin and pliable. Later, the whole body is affected, distension occurring by the normally flattened body and gills becoming increasingly circular in cross-section and by elongation of the body through the straightening out of the normally infolded intersegmental membranes. The latter process is most marked along the dorsal surface so that the body becomes flexed ventralwards, rigidly, and the limbs of the mid-thoracic segments do not touch the substratum. Muscular movements, depending on normal intersegmental mobility, eventually become impossible. There is probably no stretching of the material of the exoskeleton. Excessively hydrated animals experience difficulty in ecdysis, the condition preventing the necessary contraction of the body[2].

Individuals survive for periods up to sixteen days after the development of visible distension. The amplitude, rate and rhythm of the heart remain apparently normal until the final stages when there is slowing, decreased amplitude, irregular rhythm and asynchrony between the two ends of the elongated organ.

The condition is relieved immediately throughout the body by permitting hæmorrhage, either by piercing the body-wall or by removing a limb. There is an apparent return to complete normality and the distension is clearly hydræmic and not œdemic in nature. The body-wall is not passively distended, but develops considerable tension. Normal muscular movements are restored immediately by deflation. The relief is temporary (1–3 hours).

The distension may be reduced by hypertonic concentrations of such solutes as sodium chloride, sugar and gum arabic in the external medium, the large molecules being the most effective in equimolar concentrations. Relief persists for 12–24 hours. Moderate desiccation, of course, reduces the condition.

Distension due to histological fixation, a familiar problem, may be avoided by opening up the body cavity before fixation or by dropping the animals into water at 65° C. for 15 sec. as a preliminary to chemical fixation. Apart from the avoidance of distension, the histological picture is considerably improved by these methods. Heat-treatment denatures the proteins (judged by opacity) throughout the body and presumably inactivates a water-absorbing mechanism. The most powerful chemical fixatives fix only exposed and thin-walled structures, such as the gills, the rate of penetration into the body being too slow to effect fixation or to prevent fluid distension. It seems probable that the gills are important in the control of water balance.

In such Crustacea as amphipod *Mimonectes*, a pronounced distension of the body would seem to be a normal adaptation to a specialized mode of life.

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[1] Wright, S., "Applied Physiology" (Oxford, 1945), see pp. 563–67.
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Morphology of *B. megatherium* Bacteriophage

MUCH attention is at present being paid to the fundamental problem of the relationship between the viruses and their host cells. The action of bacteriophage on bacteria is in many ways analogous to the action of a virus upon an animal cell. Since the bacterium-bacteriophage system is the less complex, and more amenable to electron microscopical study than living cells, the mechanism of bacteriophage action is a subject of active research.

It has already been shown by Luria, Delbrück and Anderson[1] that the T_2 coliphage is sperm-shaped, and hence easily identified in electron micrographs. The *Salmonella pullorum* and *Rhizobium leguminosarum* bacteriophages have also been shown to have a similar morphology[2,3]. In this laboratory, we have recently found that the No. 1 phage of *B. megatherium* also possesses a readily identified sperm-like structure. The large size of the *megatherium* bacillus makes it readily visible in the light microscope under oblique illumination, and the action of phage on this organism has already been discerned with the light microscope[4].

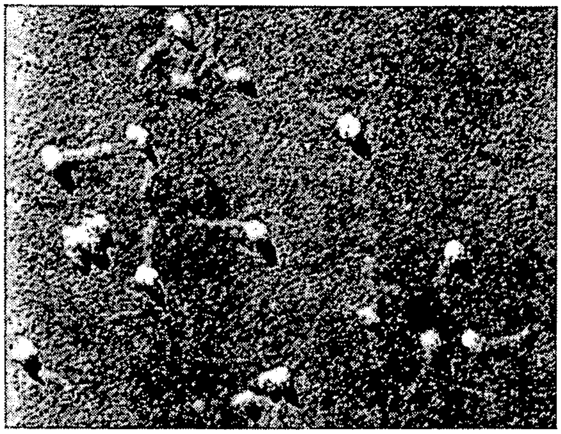
Material. Cowles described[4] the characters of two phages, isolated from sewage and designated No. 1 and No. 2, active against seven different strains of *B. megatherium*. The phages were inactivated by heating to 75° C. for 10 min. Further observations[5] on strain of *B. megatherium* No. 899 (De Doreen de Jong) showed that bacteriophage could be demonstrated in filtrates of cultures developed from spores heated to 90° C.

A culture of *B. megatherium* No. 1 isolated in 1904 and a quantity of phage No. 1 were received from

Dr. Cowles, and concentrated preparations of phage were prepared as follows.

Technique. Broth culture of *B. megatherium* incubated at 37° C. for 5 hours was inoculated on 2 per cent nutrient agar plates, and allowed to dry. Thereafter 1/200 c.c. volumes of phage were placed on the surface of the inoculated media, allowed to dry, incubated at 37° C. for 24 hours, and lysed areas transferred with a loop to broth. The suspension of phage was centrifuged at 2,500 r.p.m. for 30 minutes, to deposit vegetative forms, and the supernatant removed. After repeating this procedure eight times, a concentration of No. 1 phage active to a dilution of 10^{-6} against *B. megatherium* No. 1 was eventually attained.

This suspension was centrifuged in narrow flat-type tubes (3 mm. by 10 cm.) in the Swedish angle centrifuge at 4,200 r.p.m. for 2 hours, and the deposit was resuspended in a few drops of saline. Electron microscope mounts were made on 'Formvar' films and rinsed in distilled water to remove salt after the customary manner. The mounts were then shadow-cast with about 50 A. of chromium at such an angle that shadow-length to object height ratio was 3·5 : 1.



Results. The accompanying photograph shows a group of *megatherium* phage photographed on an R.C.A. model EMU microscope without an objective diaphragm. Using a microscope calibrated by the use of a grading replica, our measurements show that the circular head of the phage is approximately 100 μ in diameter and 40 μ high. The 'tail' is 260 μ long by 40 μ wide. It will be noted that the tail is flat and somewhat undulating in comparison with the straight rod-like tail of the T_2 coliphage. *B. megatherium* is one of the larger bacteria susceptible to phage action, and its No. 1 phage probably one of the largest bacteriophages.

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Two New Antarctic Leeches

I should like to give here a short preliminary note upon two new antarctic fish leeches. A paper on them has been prepared, but as printing conditions in Norway at present are very difficult, rather a long time may pass before it will be published.

Trulliobdella capitis n. g. n. sp. was collected from *Parachænichtys georgianus* (Fischer) and *Chænocephalus bouvetensis* Nybelin. A paper on the latter fish is in the press. The leeches were located to the dorsal part of the fishes' heads, between the eyes. The parasite is dorso-ventrally flattened, showing two body regions, a shorter and more slender præclitellar part, and a postclitellar part which is twice as long and broad. Eyes are present on the oral sucker as well as on the most anterior annuli. The normal somite possesses three primary and six secondary annuli. The mouth opening of the cup-shaped oral sucker is subterminal; the stomach is without posteriorly directed gastric cæca. A 'fold organ' is inserted between the intestine and the rectum. Somital vascular lacunæ are found outside the dermal musculature. The length of the animal is 10–39 mm. As the present species cannot be grouped within any hitherto known genus, a new genus had to be established. Its nearest relatives seem to be the genera *Pterobdella*, *Pterobdellina* and *Phyllobdella*, as these genera are characterized by the absence of posteriorly directed gastric cæca. On the other hand, it seems related to the genus *Branchellion*, because both genera show a 'fold organ' between the intestine and the rectum.

Cryobdellina bacilliformis n. g. n. sp. was collected from the oral cavity of *Parachænichtys georgianus* (Fischer). There can be no doubt that this leech is closely related to the genus *Cryobdella* Harding, 1922. Common characteristics to both genera are the presence of four testes sacs, the arrangement of posteriorly directed cæca, the diminutive size and the antarctic distribution. As the present species, however, possesses eyes, both on the oral and posterior sucker as well as on the most anterior annuli, and four distinct lateral intestinal pouches, it cannot be assigned to the genus mentioned, and a new provisional genus had to be established. A further characteristic of the animal is the central position of the mouth in the bell-shaped oral sucker, the latter being heptagonal in outline because of dorso-marginal short broad papillæ. Only two specimens were at my disposal, and both seem not to be fully mature, as questionable signs of ovisacs only could be traced. Four pairs of testes sacs were, however, present. The length of the animal was 7–8 mm.

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Wild and Cultivated Rice

The systematics of rice is, as systematists will agree, a matter of more than academic or departmental interest. The improvement of this important cereal depends on its sound classification. To this end the remarks of Dr. D. Chatterjee[1] seem to fall short of what is needed.

One part of Dr. Chatterjee's article consists of unacknowledged verbatim extracts from the first two chapters of a popular essay written twenty years ago by the late Harold Peake[2]. The passages on the "three successive stages of civilization", "hunting in packs", and so on, might have been taken from Horace or Lucretius. And the transcribed account of "recent discoveries in India", although more up to date, is no longer appropriate to Mohenjo-daro.

The work of Vavilov published in 1926 is referred to by Dr. Chatterjee. Here the disadvantage of relying on what Peake wrote in 1928 becomes serious. It is not the most recent of Vavilov's works, nor does it deal with rice as his later work does. Dr. Chatterjee might, however, have noticed one point in this early paper of great significance: Vavilov's account of *Triticum* establishes the principle in systematics (already well understood in genetics at that time) that chromosome numbers, where they vary, must be a basic criterion in the classification of plants.

Not since 1918 has anyone attempted to discuss the species of wheat without reference to their chromosome numbers. It is due to this fact that the classification of *Triticum* is now so well agreed and its application to breeding, to problems of fertility and sterility, and of hybridization and selection, so fruitfully practised.

Now, since 1936, the species of rice, like those of wheat, have been known to fall into inter-sterile groups defined by their chromosome numbers. Our knowledge of the genus is still fragmentary, but the following points seem to emerge. There are two groups of species, diploid and tetraploid. Each of them contributes types cultivated both for grain and for fodder; and the tetraploid group extends from East Africa, where Dr. Chatterjee has omitted to map *Oryza eichingeri*, to the Philippine Islands, where the grain rice *O. minuta* is cultivated[3].

To these matters Dr. Chatterjee makes no reference. Yet, whether for estimating ancestry, or raising posterity, or even for the more recondite tasks of comparing spikelets and discovering synonymy, it is important to know whether the plant one is dealing with is *O. eichingeri* with 48, as opposed to *O. eichingeri* with 24, chromosomes. It is more important even than to know whether one is dealing with *O. eichingeri* Peter, as opposed to *O. eichingeri* Paul!

What we need to know now, in rice as in many other groups, is whether the herbarium names in fact belong to the living plants which have been found to have particular chromosome numbers. When Dr. Chatterjee has procured these "much-needed data" we may be able to apply his botanical observations to some useful purpose.

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Aug. 21.

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MY article on the wild and cultivated rices was originally prepared at the request of the Economic Botanist, Assam, who is contemplating writing a popular book on rice. Owing to the special nature of my assignment, and also due to my limited knowledge of cytogenetics, I had to restrict myself to the morphology of the rice spikelet and preparation of a key to the species and their enumeration and synonymy. This was stated in the beginning of my article. The published summary in *Nature* essentially deals with this part of my effort, and the omission of cytological discussions and the chromosome numbers of the species of *Oryza* was intentional. This aspect of the subject is being dealt with by my friend in Assam, from other sources. As such, my article, for obvious reasons, was meant to deal only with a particular portion of the problem and should be judged on its own merits. I agree with Dr. Darlington that the chromosome numbers, wherever available, should be given. This enables us to have a better idea of a species and its affinities with other allied species and genera. But whether the chromosome numbers should be all-important and should form the basis of classification in plants is a subject open to controversy between the cytologists and the taxonomists. As a taxonomist, I believe that a natural system of classification of plants based on synthetic methods over a long period has fairly, and within reasonable limits, stood the test of cytologists.

Vavilov's essays on the origin of cultivated plants and Peake's book on the origin of agriculture were of general interest and were freely consulted. A small portion from the latter book was used in a modified form, and in an effort to avoid a large number of inverted commas in a connected text of few lines it was thought fit to acknowledge the book at the end. This has been duly done in the second list of reference books given in my article.

The omission to plot *Oryza eichingeri* in East Africa in the map is very much regretted. This was accidental and I am grateful to Dr. Darlington for directing attention to it. This will be corrected in the fuller paper.

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Aug. 26.

Maturation of Megaloblasts in Bone Marrow Cultures

INVESTIGATING the effect of folic acid upon the maturation of megaloblasts, we used a modified bone-marrow culture method of Osgood. During our experiments we saw megaloblasts ripen not only in media containing folic acid, but also in those which contained only the prescribed Osgood medium (65 per cent Gey solution and 35 per cent serum obtained from placental vein). Supposing that the placental serum might contain certain substances responsible for cell growth, in the next stage of our experiment we used normal adult serum instead of the placental one. To our surprise we found that megaloblasts ripen even in these conditions. (At the beginning, the megaloblast ratio of all nucleated red blood corpuscles was 50 per cent, 48 hours later only 8 per cent.) In the third stage of our experiments we further modified Osgood's method and used sera obtained from patients suffering from pernicious anæmia. We had every reason to suppose that normal serum might contain the anti-anæmic factor, which is absent in pernicious anæmia sera. Hence, we put the bone marrow simultaneously into vessels containing normal, and others containing pernicious anæmia sera, both prepared under the same conditions as above. The surprising result was that megaloblasts ripened in the pernicious anæmia medium too, although to a lesser extent. (Example: decrease of the relative number of the megaloblasts in 48 hours from 50 to 18 per cent.)

We suspected—rather boldly—that the megaloblasts in the media containing pernicious anæmia serum ripen less perhaps because there is an inhibitory factor which is diluted by the Gey solution. In the next experiment we changed the proportions, using as medium 65 per cent pernicious anæmia serum and only 35 per cent Gey solution. The result was that no ripening of megaloblasts took place (37·5 per cent at the beginning and 36·5 per cent after 48 hours). Our supposition seemed to be justified, so in the next experiments we made the following parallel cultures: 35 per cent normal serum and 65 per cent Gey solution; 65 per cent normal serum and 35 per cent Gey solution; 35 per cent pernicious anæmia serum and 65 per cent Gey solution; 65 per cent pernicious anæmia serum and 35 per cent Gey solution. Every experiment had a double control and in each case we used the same marrow for the different media. The results were: megaloblasts ripened better in concentrated than in diluted normal sera, but much less (or not at all) in concentrated than in diluted pernicious anæmia ones.

We conclude, therefore, that: (1) folic acid acts directly upon the megaloblasts; (2) pernicious anæmia serum seems to contain an inhibitory substance exerting its effect upon the ripening of the megaloblasts. Its degree of action depends upon the concentration or dilution of the pernicious anæmia serum in the marrow cultures.

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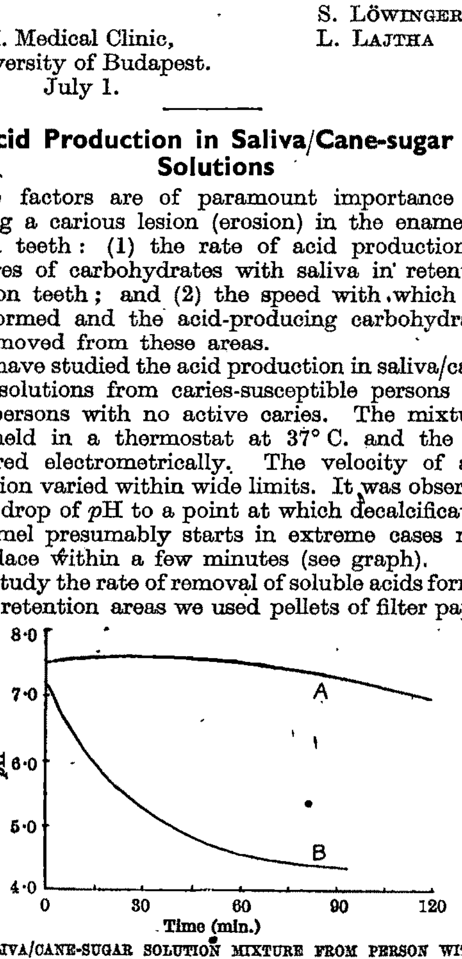
July 1.

Acid Production in Saliva/Cane-sugar Solutions

Two factors are of paramount importance for starting a carious lesion (erosion) in the enamel of human teeth: (1) the rate of acid production in mixtures of carbohydrates with saliva in retention areas on teeth; and (2) the speed with which the acid formed and the acid-producing carbohydrates are removed from these areas.

We have studied the acid production in saliva/cane-sugar solutions from caries-susceptible persons and from persons with no active caries. The mixtures were held in a thermostat at 37° C. and the pH measured electrometrically. The velocity of acid formation varied within wide limits. It was observed that a drop of pH to a point at which decalcification of enamel presumably starts in extreme cases may take place within a few minutes (see graph).

To study the rate of removal of soluble acids formed in the retention areas we used pellets of filter paper, dyed in a water-soluble dye, pressed in between the approximal surfaces of teeth. We have found that after two hours without any food or drink intake, more than 50 per cent of the dye was washed out.



A, SALIVA/CANE-SUGAR SOLUTION MIXTURE FROM PERSON WITH NO ACTIVE CARIES; *B*, SALIVA/SUGAR-CANE SOLUTION MIXTURE FROM PERSON WITH RAMPANT CARIES

After centrifuging salivas or filtering through ordinary paper filters, the centrifugates were found inactive. The precipitates, however, gave when mixed with cane-sugar solutions a surprisingly rapid acid formation.

On the basis of these observations, it is evident that the elements in saliva capable of producing acid rapidly after incubation with cane-sugar solution are concentrated in the precipitating masses (mucin, epithelial cells, leucocytes, micro-organisms, etc.). The rate of acid production is so rapid that we doubt very much whether this process is caused, as hitherto suggested, by the activity of micro-organisms; we believe it is probably due to an enzyme system already present in saliva.

In persons with slow acid production in saliva/cane-sugar solutions, we have at times of intermittent illness found the rate of acid formation greatly accelerated; in such cases 'normal' values are reached fairly rapidly during convalescence.

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Oslo. Oct. 2.

Effects of Anterior Pituitary Extract and Hypophysectomy on Blood-Sugar Levels after Injection of Alloxan

Kirschbaum, Wells and Molander[1] find that alloxan hyperglycæmia does not occur but is replaced by fatal hypoglycæmia in fasting rats from which the pituitary gland had been removed, either immediately before, or 72 hours before, injection of alloxan. Houssay, Orías and Sara[2], using recently hypophysectomized toads, say that alloxan hyperglycæmia is not abolished by hypophysectomy. Martínez and Orías[3] find that injection of alloxan induces some degree of hypoglycæmia in normal rats and in rats hypophysectomized six days previously. Normal blood-sugar levels in both cases were regained 48 hours after injection.

Experiments in this laboratory show the disagreement in the literature is due to: (*a*) different periods of time elapsing between operation and injection of alloxan; (*b*) failure to take into account the glycostatic function of the anterior pituitary gland; (*c*) insufficient number of, or no, control operations. This latter criticism also applies to experiments of Kirschbaum *et al.*, and Goldner and Gomori[4] on adrenalectomy and effect of alloxan, and may explain the disagreement between their results and those of Houssay *et al.*

The animals used in the present work were inbred hooded rats weighing between 100 and 150 gm. and wild rabbits obtained as 200–300 gm. kittens and raised in the laboratory. Hypophysectomy was carried out on rats under 'Avertin' anæsthesia. Control operations consisted of the same procedure, except that drilling ceased before the pituitary was reached (sham-operated). Completeness of removal of the pituitary was checked at autopsy in all cases, and the results from incompletely hypophysectomized animals rejected. Rats were fasted 24 hours before injection of alloxan, and rabbits 17 hours. Under these conditions it was found that intraperitoneal injection of 200 mgm./kgm. of alloxan brought about no change in blood-sugar level of the intact hooded rat 4 hours after injection. On rats sham-operated 24 hours previously, blood-sugar values ranging from marked hypoglycæmia (43 mgm. per cent) to marked hyperglycæmia (352 mgm. per cent) were found four hours after injection of alloxan. Rats hypophysectomized 24 hours previously were consistently hypoglycæmic (average value of 49 mgm. per cent) four hours after injection. However, it is difficult to see on what statistically permissible grounds the figures for the sham-operated group can be averaged and the figure compared with the mean figure for the hypophysectomized group. It would appear that some factor other than hypophysectomy alone is involved in the hypoglycæmia of the hypophysectomized group. These results indicate that, in rats, operations carried out a short period before commencement of the experiment cause unpredictable changes in blood-sugar level after alloxan, which invalidate the experiment.

If, however, the rats were allowed to recover from the operation for a period of eight days, those subjected to the sham operation were normal in that they showed no blood-sugar change four hours after intraperitoneal injection of 200 mgm./kgm. of alloxan. These had apparently recovered from the effect of the operation and behaved like intact rats injected with alloxan. Those rats subjected to the operation of hypophysectomy eight days previously, whether receiving alloxan or control injections of water, showed to a similar degree the well-known spontaneous hypoglycæmia of fasting hypophysectomized animals (average of 63 mgm. per cent for the alloxan group and average of 47 mgm. per cent for group receiving water). This spontaneous hypoglycæmia is due to lack of the glycostatic action of the anterior pituitary.

The effect on blood-sugar levels after injection of alloxan of the opposite procedure to hypophysectomy, namely, pretreatment by parenteral injection of anterior pituitary extract, was studied in rabbits. The extract used was an alkaline extract of fresh ox anterior lobes made according to the method of Young[5]. Pretreatment consisted of three subcutaneous injections of the extract at 24, 17 and 3 hours before injection of alloxan. Total pretreatment dose was equivalent to 5 gm. fresh anterior lobes. The results fell into two groups according to the weight of the animals. In rabbits weighing 800 gm. or more, pretreatment with anterior pituitary extract resulted in a much greater hyperglycæmia (average figure of 160 mgm. per cent at two hours after intravenous injection of 200 mgm./kgm. of alloxan) than in rabbits not pretreated (average figure of 110 mgm. per cent at two hours). The onset of hypoglycæmia was delayed in the pretreated rabbits. Using the T test, the difference between the average curve for the pretreated rabbits and that for the untreated rabbits was significant ($P > 0\cdot05$).

In rabbits weighing 500 gm. or less, slight hyperglycæmia appeared in the pituitary pretreated animals after intravenous injection of 200 mgm./kgm. of alloxan. This hyperglycæmia (average figure of 113 mgm. per cent at two hours) was then followed by marked hypoglycæmia, but in the untreated controls only hypoglycæmia (average figure of 67 mgm. per cent at two hours) without preliminary hypoglycæmia appeared. The difference between the average curve for the pretreated rabbits and that for the untreated rabbits was significant ($P > 0\cdot02$), as was the difference between the average response for untreated 800 gm. rabbits and untreated 500 gm. rabbits ($P > 0\cdot01$).

Further work is in progress on this enhancement of alloxan hyperglycæmia, and a detailed report will be published at a later date.

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Canberra. Oct. 4.

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Sound Emitted by Dolphins

With reference to Dr. Kullenberg's observation in *Nature* of November 8, p. 648, on sounds emitted by dolphins, the following quotation from Capt. Parry's "Journal of a Voyage for the Discovery of the North West Passage", 1821, is relevant. It concerns the white whale (*Delphinapterus leucas*), p. 35. "Mr. Fisher described them to be generally from 18–20 feet in length; and he stated, that he had several times heard them emit a shrill, ringing sound, not unlike that of musical glasses when badly played. This sound, he further observed, was most distinctly heard, when they happened to swim directly beneath the boat, even when they were several feet under water, and ceased altogether on their coming to the surface."

In *Natural History*, January 1940, p. 19, there is an account of observations on dolphins kept in captivity at the Marine Studios, Florida. The writer, Arthur F. McBride, gives a description of the sounds emitted by dolphins while under water and their use as a means of communication.

During the voyage of the Danish *Atlantide* Expedition to West Africa, 1945–46, dolphins were heard to make noises under water on several occasions. These were described to me by Dr. A. F. Bruun of the University Zoological Museum, Copenhagen, as being high-pitched whistles. The sound was outside the upper limit of my range of hearing.

That dolphins are sensitive to high-pitched notes is supported by another observation made while I was in the *Atlantide*. On December 30, 1945, a school of about a hundred *Delphinus delphis* was near the ship in calm water, splashing, diving and leaping vertically out of the water. The dolphins suddenly dashed away at great speed and their disappearance coincided with the switching on of the ship's supersonic echo-sounding machine. This sensitiveness to supersonic emissions was confirmed on a later occasion.

Dr. M. Burton of this Museum and I, in company with Major H. W. Hall, the owner of the yacht *Manihine*, watched common dolphins for a few minutes under ideal conditions this summer in the eastern English Channel. The dolphins could be clearly seen swimming under water and we observed that, intermittently, a stream of fine bubbles issued from the blowholes of the animals while they were still submerged to a depth of a fathom or two. None of us heard any emission of sound, but the possibility is suggested that it may be connected with this phenomenon.

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PHYSIOLOGICAL EFFECTS OF ALKYL POLYPHOSPHATES

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DURING the War, the Germans introduced as insecticides a series of phosphate esters, including tetraethylpyrophosphate and hexaethyltetraphosphate. From information supplied to us by Mr. B. Topley, it appears probable that both these materials, in the form in which we have used them, were, in fact, mixtures of substances with the empirical composition implied by their names; in any event, it is certain that hexaethyltetraphosphate is almost instantaneously largely hydrolysed in water into simpler bodies. In toxicity tests[1,2] a characteristic syndrome of hyperexcitability, twitching, salivation and convulsions, has been noted with doses of 1–3 mgm./kgm. Dubois and Mangun[2,3] showed that these compounds are potent anticholinesterases; they are more active than diisopropylfluorophosphonate in the rat both *in vitro* and *in vivo*; this finding has been confirmed on the American roach[4].

We have examined the action of hexaethyltetraphosphate and tetraethylpyrophosphate on isolated organs in a number of species and on various systems in cats.

Action on the isolated tissues. The effects of hexaethyltetraphosphate were studied on the frog rectus abdominis muscle, the perfused rabbit heart and the rabbit and guinea pig small gut. With small doses no direct action was observed; but a progressive sensitization of the organ to acetylcholine occurred until only 1/10–1/100 of the dose of acetylcholine previously required to produce a given response was effective. The effect of this smaller dose of acetylcholine was nearly always prolonged; that is, cardiac slowing or arrest persisted for much longer periods and the gut relaxed more slowly on washing. A detectable effect first appeared with concentrations of hexaethyltetraphosphate of 10^{-8}–10^{-7} (2×10^{-8}–2×10^{-7} *M.*) and reached a peak at 10^{-6}–10^{-5} (2×10^{-6}–2×10^{-5} *M.*). The potentiation produced by hexaethyltetraphosphate persisted for at least six hours despite repeated washing out; indeed, this potentiation was always greatest after washing out the hexaethyltetraphosphate several times. In concentrations of 10^{-4}–10^{-3} *M.*, hexaethyltetraphosphate produced direct effects on the test organs. The guinea pig gut and frog rectus progressively contracted; the rabbit's heart slowed and decreased in force; the rhythmic contractions of the rabbit intestine increased in amplitude, and the resting tone rose. The rise in tone was initially annulled by atropine, but later the tone continued to rise despite atropine. Hexaethyltetraphosphate produced maximum potentiation of acetylcholine action in concentrations two hundred times smaller than is the case for diisopropylfluorophosphonate. Tetraethylpyrophosphate produced similar qualitative effects to hexaethyltetraphosphate; its action was greater but more transient; thus on the guinea pig gut some recovery was noted in 1 hr. Triethylorthophosphate in 100–1,000 times the concentration of hexaethyltetraphosphate produced a marked depression of the rabbit heart, and a small potentiation of the action of acetylcholine on the other organs (equivalent on the guinea pig ileum to 1/400 of that of hexaethyltetraphosphate).

Action of hexaethyltetraphosphate in the chloralosed cat. The toxicity syndrome on intravenous injection of hexaethyltetraphosphate in increasing doses was as follows:

0·025–0·1 mgm./kgm.: no detectable effect.

0·2–0·3 mgm./kgm.: slight bradycardia and slight fall of blood pressure.

0·4–0·6 mgm./kgm.: marked slowing of the heart (to half the initial rate) and fall of blood pressure (of 60–100 mm. mercury), which began to recover after 10–20 min. Respiration was stimulated; marked salivary and bronchial secretion, micturition and excessive bowel movements with defæcation occurred. The pupils were usually dilated, but the nictitating membrane was not retracted; sometimes pupillary constriction occurred. Muscle fasciculation and minor convulsive movements were seen and the animal responded markedly to jarring.

0·8–2·0 mgm./kgm.: almost immediate violent convulsions; very marked slowing of the heart and fall of blood pressure (to about 40 mm. mercury); profuse salivary and bronchial secretion, vigorous gut movements and defæcation. The animal's condition rapidly deteriorated and death usually occurred in less than one hour.

After atropinization most of the visceral effects were abolished and doses up to 100 mgm./kgm. were given intravenously without producing serious visceral or respiratory changes.

Tetraethylpyrophosphate produced similar effects in comparable doses; triethylorthophosphate produced no systemic effects.

Action of hexaethyltetraphosphate on response to peripheral stimulation of vagus (cat). In control experiments supramaximal stimulation at 1, 2, 4, 10, 25, 50/sec. produced graded slowing of the heart and fall of blood pressure. After giving hexaethyltetraphosphate the maximum immediate effect of a given stimulus was only increased by 10–40 per cent, but the recovery period was much prolonged. On stimulating at 10/sec. for 5 sec. the area under the blood-pressure and heart-rate recovery curves was doubled by 0·2 mgm./kgm., quadrupled by 0·4 mgm./kgm. and increased 10–20 times by 0·8 mgm./kgm. These effects lasted for at least 6 hr. 0·4 mgm./kgm. of hexaethyltetraphosphate caused a 2–4 fold potentiation of the bradycardia produced by intravenous acetylcholine. After 2 mgm./kgm. of hexaethyltetraphosphate the animal became completely unresponsive to vagal stimulation; whereas 0·1 μgm. of acetylcholine had previously produced a marked fall in blood pressure, no response was obtained until 2 mgm. of acetylcholine was injected, when a small rise of blood pressure occurred.

Effect of salivary secretion. A marked flow of saliva occurred on injection of 0·4 mgm./kgm. of tetraethylpyrophosphate even after the chorda tympani had been cut; during this time no increase in salivary flow occurred on stimulating the peripheral end of the nerve; when this spontaneous flow ceased the response to nerve stimulation returned to its previous magnitude.

Effect on nictitating membrane. The response of the nictitating membrane to peripheral stimulation of the cervical sympathetic trunk was unchanged until 1 mgm./kgm. of hexaethyltetraphosphate was injected, when some potentiation occurred.

Conjunctival application of 1 drop of 1 per cent hexaethyltetraphosphate solution constricted the pupil.

Effect of intravenous hexaethyltetraphosphate on the nerve muscle response in chloralosed atropinized cats. The popliteal nerve was stimulated with maximal shocks from a thyratron and coil once every 2·5 sec.; the response of the gastrocnemius-soleus muscle was recorded (*a*) mechanically by a torsion lever on a smoked drum, and (*b*) electrically from belly-tendon leads. Doses of hexaethyltetraphosphate smaller than 0·2–0·3 mgm./kgm. had no apparent effect. Further doses of the order of 0·5 mgm./kgm. had a marked potentiating action on the nerve muscle response. The mechanical response increased by 40–80 per cent, was maintained for some minutes slightly below peak level, and than gradually returned to normal. Action potentials showed no increase in amplitude but a repetitive response developed, consisting of one or two additional synchronous discharges, followed by an asynchronous discharge of smaller amplitude which persisted for about 100 m.sec. The control synchronous action potentials had a duration of 10 m.sec. The nerve muscle potentiating doses of hexaethyltetraphosphate had very little effect on blood pressure and produced only slight fasciculation. Further increase in the dose of hexaethyltetraphosphate produced additional potentiation followed by depression of the nerve muscle response; as the dose was still further increased, the initial potentiation became less and the subsequent depression more profound. Doses of hexaethyltetraphosphate of the order of 2 mgm./kgm. were purely depressant. Doses (0·5 mgm./kgm.) which potentiated the response of the nerve muscle preparation reversed a 90 per cent depression of the nerve muscle response caused by a previous appropriate dose of a curare preparation ('Intocostrin'). Essentially similar effects on the nerve muscle responses were produced by tetraethylpyrophosphate.

Action of hexaethyltetraphosphate on spinal reflexes. This was studied in decerebrate and chloralosed cats with and without atropine. The reflexes examined, namely, knee-jerk, flexor reflex and crossed extensor reflex, were generally initially potentiated; these changes were accompanied by variable degrees of fasciculation of peripheral origin. Increase of resting extensor tone and convulsions, sometimes violent and prolonged, were noted. A small increase in the dose of hexaethyltetraphosphate frequently converted increased reflex responses into depression. The effect of the drug was sometimes different on different reflexes; thus depression of the knee-jerk might coincide with potentiation of the flexor reflex. Convulsions have also been produced by tetraethylpyrophosphate; these were usually mild and transitory, but muscle fasciculation was very marked.

Intrathecal injection of hexaethyltetraphosphate produced with increasing doses an increased 'repetitive' knee-jerk (0·05 mgm./kgm.), increased crossed extensor reflex (0·4 mgm./kgm.), mild convulsions (0·6 mgm./kgm.) and increased resting extensor tone followed by very violent convulsions (4 mgm./kgm.). The initial phenomena were unaccompanied by any change in blood pressure or in the nerve muscle response. The very violent convulsions produced by the larger doses of hexaethyltetraphosphate were, however, at their peak, associated with an increase in the nerve muscle response, suggesting slight absorption of the drug into the general circulation. The hexaethyltetraphosphate convulsions were phasic, and sometimes a second burst of convulsions occurred when the nerve muscle response had returned to its control condition. The evidence indicates that hexaethyltetraphosphate (like diisopropylfluorophosphonate[5] and the tertiary anticholinesterases[6]) has a central excitant action on the spinal cord.

We are indebted to Mr. B. Topley for chemical information and to Messrs. Pal Chemicals for supplies of materials.

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ETIOLOGY OF STRAWBERRY VIRUS DISEASES

By Dr. CONWAY A. WOOD and Dr. T. WHITEHEAD

STRAWBERRY virus diseases in Great Britain have hitherto been described mainly on the basis of the symptoms shown by the 'sensitive' variety Royal Sovereign[1,2], and are classified under the terms 'crinkle' and 'yellow-edge', each of which includes a wide range of symptom-intensity. It is now recognized that certain of the so-called 'tolerant' varieties, such as Huxley and Oberschlesien, also suffer degeneration due to virus infection, exhibiting symptoms which may resemble closely those of yellow-edge in Royal Sovereign[3,4]. The wild strawberry, *Fragaria vesca* L., owing mainly to its marked virus sensitivity, has been much employed as an indicator plant in the study of these diseases.

In investigations during the period 1938–45, we concentrated at first on an analysis of the virus entity causing 'severe crinkle' in Royal Sovereign, the complex nature of which had been suggested by earlier workers[5,6]. Efforts to segregate component viruses by (i) the use of possible differential insect vectors, (ii) comparison of aphis-transmission with graft-transmission, and (iii) the use of possible differential host plants were all unsuccessful, but a separation of 'non-persistent' and 'persistent' virus components was at length accomplished by daily transfers of infective aphides (*Pentatrichopus* (*Capitophorus*) *fragariæ* Theob.) along series of *F. vesca* indicators. Distinct symptomatological differences appeared between the first plants—that is, those colonized directly from the infector-plants on the first day of the experiment—and all subsequent plants. Both components were later retransmitted from *F. vesca* to other *F. vesca* plants, and to Royal Sovereign, both by graft- and aphis-transmissions. Evidence was obtained that separation of the components is not affected either by post-infection starvation of the vectors or by a sojourn of the latter on the virus-immune plant *Potentilla anserina* L.[4] between infection-feeding and feeding on the indicator plant, but is dependent solely upon lapse of time between these two feedings.

The results led us to the conclusion that plants of Royal Sovereign suffering from severe crinkle contain two viruses, one of which persists in the aphis vector for several days and the other for not more than one day. These results, however, were obtained only by the use of aphides which were reared on the Royal Sovereign infector plants. When similar experiments were conducted with aphides given only short infection-feeds (up to 4 hr.) the aphides remained infective only for a short time, and symptoms of the non-persistent virus type alone were produced in *F. vesca*. The persistent component either was not transmitted, or was retained in the aphides for no longer than was the non-persistent component. This agrees with the results of contemporaneous experiments at East Malling[7], in which aphides fed for short periods (up to 24 hr.) on certain infector plants, including 'severe crinkle' Royal Sovereign, transmitted only a non-persistent virus.

A beginning was later made in the analysis of other diseases met with in the field. It was found that 'mild crinkle' in Royal Sovereign most probably contains only a non-persistent virus, whereas both non-persistent and persistent viruses were obtained from Royal Sovereign affected with yellow-edge; from 'degenerate' Huxley showing yellow-edge-like symptoms; and even from a normal, vigorous, clonal stock of Huxley ('Malling 44'). It is considered that the virus components of yellow-edge in Royal Sovereign and of 'degenerate' Huxley are of similar type and are perhaps identical. The viruses in normal, vigorous Huxley (M44) and in a Royal Sovereign stock (M35) showing mild crinkle are also of similar type, but are probably not identical since only the former has given definite evidence of a persistent component. The persistent viruses isolated from 'degenerate' Huxley, from vigorous Huxley and from yellow-edge in Royal Sovereign, all appear to differ from the persistent virus in Royal Sovereign plants showing severe crinkle.

These tentative groupings were supported by the results of a later experiment with the variety Huxley. Degeneration was produced in plants of the M44 clone of this variety by colonizing them with aphides (*P. fragariæ*) reared on Royal Sovereign showing yellow-edge or on 'degenerate' Huxley or Oberschlesien plants (both showing symptoms resembling yellow-edge). Degeneration did not occur, however, where the aphides used had fed on Royal Sovereign showing mild or severe crinkle or on vigorous plants of Huxley or Oberschlesien. We at no time obtained evidence that the two latter varieties can carry, without symptoms, viruses capable of causing yellow-edge in Royal Sovereign.

In the course of these studies the symptoms of crinkle in Royal Sovereign and in *F. vesca* were analysed into 'unit characters', comprising reduction in size, distortion, leaf malformation, chlorosis and pigmentation, the varying proportions of which give rise to the wide range of symptoms shown by infected Royal Sovereign plants in the field. An appreciable variability in the clinical picture also occurs among plants of either *Fragaria vesca* or *F. moschata* Duch.—even though clonal—when these are infected with either mild or severe crinkle under conditions made as uniform as possible. Many carefully investigated examples led us to the opinion that symptom variability, especially in *F. vesca* but also in Royal Sovereign, is a function not only of virus content but also of the individuality of the plant in its reaction to a given virus, and that this is a factor to be taken into account both in fundamental research and in field surveys.

This work, a full account of which will be published later, was carried out at the School of Agriculture, University College of North Wales, Bangor, with the aid of a grant from the Agricultural Research Council.

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PROGRESS IN ELECTRON MICROSCOPY

MORE than a hundred and fifty people, including visitors from the United States, Holland and France, attended the conference of the Electron Microscopy Group of the Institute of Physics which was held during September 16–17 at the University of Leeds. The meeting opened with addresses of welcome from the Vice-Chancellor of the University and from Prof. R. Whiddington; Sir Charles Darwin was in the chair.

The first session was devoted mainly to biological topics. Drs. R. Reed and K. M. Rudall (Department of Biomolecular Structure, Leeds), in a paper illustrated by many slides and enlarged micrograms, described work on gold-shadowed replicas of (*a*) the non-banded collagen-type fibres of the earthworm cuticle, and (*b*) the cell structure of striated muscle fibres from the frog. In the former case valuable information is provided on the manner of growth of the fibres and how they are arranged in layers of alternating fibre direction; while in the latter further details showing the organisation of the sarcolemma, sarcoplasm and striated myofibrils are clearly revealed. Investigations such as these, the results of which are now being reported from many countries, make it evident that the time is rapidly approaching when a new histology will have to be written.

Dr. V. E. Cosslett (Cavendish Laboratory) and his colleagues dealt with the preparation of bacteria for electron microscopic examination. Many cells are too opaque to show internal detail when using the 60 kV. beams of most present-day microscopes, but methods had been developed for rendering them more transparent, for example, by treatment with acetic acid vapour, ether vapour, or hydrochloric acid. Internal structures have also been revealed by light metal-shadowing, or by normal evaporation of metals on to the organism, or by the use of very thin supporting films of beryllium. Details of the preparation and handling of such films were given and photographs showed their obvious value in this type of study. Dr. N. E. Brieger (Papworth, Cambridge) further illustrated the methods by reference to the growth of avian tubercular bacilli on a solid medium. Dr. F. M. L. Sheffield (Rothamsted Experimental Station) described how certain plant viruses produce abnormal inclusion bodies in the cells of the host. By micrurgical methods some of these bodies have been isolated and examined in the electron microscope and their contents compared with other parts of healthy and infected cells. In cells infected with tobacco mosaic virus, the virus particles are located not only in the cell nuclei, but in other parts of the cell besides. In severe etch disease, an examination of nuclear and cytoplasmic inclusions revealed crystalline bodies, many of which show details of internal structure. In a paper by Dr. L. Dmochowski and Prof. R. D. Passey (Department of Experimental Pathology and Cancer Research, Leeds) and Prof. W. T. Astbury and Dr. R. Reed (Department of Biomolecular Structure, Leeds), extracts of normal and malignant tissues derived from mice of high and low breast-cancer strains were studied. Roughly spherical particles of about 200 A. diameter were found in the extracts of lactating breast tissues and of breast tumour tissues obtained from mice of three high-cancer strains. Extracts of lactating breast tissues and of experimentally induced breast tumours from mice of two low-cancer strains were found to be free of these particles. All extracts are being examined for tumour-inducing activity in susceptible mice, and the results of these tests are keenly awaited. [See also *Nature*, October 25, p. 565.] Dr. van Dorsten (Philips, Eindhoven) illustrated the possibilities in the use of high-velocity beams by showing photographs of yeast cells taken with electrons ranging from 70 to 300 kV. At the higher voltages there was surprisingly little loss of contrast, and internal detail was clearly seen.

The remainder of the session was devoted to problems of technique. Dr. A. E. J. Vickers (Imperial Chemical Industries, Ltd., Billingham) referred to various devices for simplifying the manipulation of grids covered with thin supporting films. The photographic methods employed at Billingham were mentioned; since the electron beam often adversely affects the specimen, photography after a fixed time interval is recommended to obtain comparable micrograms. Mr. M. E. Haine (now of A.E.I. Research Laboratories, Aldermaston) gave an account of the new Metrovick experimental microscope. The new model employs a three-lens system which allows a wide control of magnification (1,000–50,000 times at 50 kV.) with a great reduction in the size of the instrument. The pumping-out time from atmospheric pressure, even with the small diffusion pump used, is only about 2½ minutes. No air-locks are necessary, and a precision-made specimen stage of a robust design is thereby made possible. Improved electron gun performance gives usable image brightness even at the highest magnifications: at present the instrument operates at 50 kV., but higher voltages are allowed for in the design. The instrument was demonstrated at the Conference and was enthusiastically examined by a large number of visitors. A paper on asymmetry in electrostatic lenses and its correction was read by Prof. P. Grivet (TSF Laboratory, Paris). A theoretical treatment showed that lens asymmetry is due mostly to mechanical defects, and mention was made of a correcting device consisting of four solenoids spaced 90° apart which could be rotated about the axis of the lens. In discussion it was agreed that such a device would be successful, but doubt was expressed whether it would be easily workable. Dr. Bruck, of the same Laboratory, reported on a simplified form of microscope for the study of cathodic emission. The object surface (about 3 mm. in diameter) was easily changeable and could be heated to 2,500° C. by electron bombardment. Magnifications from 50 to 2,000 were provided by a two-stage electrostatic lens system, and preliminary results from various metallic surfaces were presented.

On September 17, Prof. W. T. Astbury was in the chair, and the time was devoted to problems of specimen examination. Dr. V. E. Cosslett (Cambridge) demonstrated that specimens exposed to the electron beam for some time often show a loss of contrast and considerable visible growth. These effects were especially strong on particles in direct contact with the specimen grids, but less noticeable on material supported on collodion or similar non-conducting films. Studies with different specimens on a variety of grids suggested that the effects arise from a contamination, partly from the specimen grid itself and partly from traces of organic material which are deposited on the specimen and grid. Where particle size is sought, Dr. Cosslett suggested the use of cleaned grids, a clean vacuum and specimens supported on non-conducting films. Photography in the central regions of the grid spaces was also recommended. Mr. I. M. Dawson (National Institute for Medical Research, Hampstead), in a study of the metal-shadowing technique, reported on the degree of gold aggregation occurring on different types of supporting film, as assessed by electron diffraction methods. The crystallite size of gold deposited on graphite films, for example, was found to be much greater than on collodion films. Evidence was given to show that direct shadowing of gold on to a specimen already mounted on a supporting film leads to more aggregation than if the metal is first deposited on the specimen and removed later by a stripping technique. It was considered that light metal-shadowing leads to less artefact production, and support was given for the contention that with metal-shadowed specimens further evaporation and deposition of metal may occur during examination in the microscope.

The Conference ended with a discussion on the most suitable choice of photographic material. Dr. R. Reed and Mr. A. Millard (Leeds) gave the results of testing a number of plates and films. Certain emulsions were mentioned as having ample contrast and reasonable grain size, yet showing a rapid response to electrons. The advantages of such fast emulsions were listed, the chief being that they minimize the risk of image movement during exposure. Particular emphasis was laid on the use of 35-mm. film, since the precision techniques of miniature photography can then be applied. In discussion it emerged that the high sensitivities quoted were in some way connected with small-grained emulsions of a high silver/gelatin ratio. Further tests on various plates and films were reported by Mr. I. M. Dawson, who also described a successful roll-film adaptor for use in the Siemens type of microscope. It was mentioned that when non-conducting materials are used in such electron cameras, attention must be paid to the problem of the dispersal of charge on the recording film.

In conclusion, it is gratifying to report that teething troubles in British electron microscopy are now more or less over, and that, so far as present conditions permit, the outlook is full of promise. Not only have the new techniques been learned; they are being actively applied and developed in the elucidation of many fundamental problems, particularly in the biological field. It may be claimed that the new Electron Microscopy Group of the Institute of Physics is now safely launched, and the growing membership and increasing vigour of its discussions augur well for the future.

More complete accounts of the contributions summarized above will be published elsewhere.

R. Reed

FORESTRY IN BRITISH COLONIAL TERRITORIES

IN the Forest Administration Report for Nigeria (Gov. Printer, Lagos, 1945; London: Crown Agents for the Colonies. 4*s*.) it is stated that in future the forest year will close at the end of March instead of at the end of December, due to the fact that at the end of December most of the forest work carried out in the cold-weather season is only half completed. In India the close of the forest year has always been March 31 for the same early recognized reason. The report in question, therefore, is dated from January 1, 1944, to March 31, 1945. In it we read that yet another revision of the forest policy of the Government was approved in February, 1945. The objects are briefly summed up. Since subsistence farming by a rapidly increasing population is the major industry of the country, the forest policy aims at preserving the climatic and physical condition of the country, its soil fertility and its water supplies by the maintenance and improvement of the vegetation cover, and at supplying in perpetuity and as cheaply as possible all the forest produce both as raw material and as the product of forest industries, required for the well-being of the inhabitants of the country.

Because of the growing demand in Nigeria for land for cultivation, it is essential that the forest estate should be secure, well distributed, and intensively managed, and that exploitation be controlled and improved and forest industries initiated and developed to prevent waste of land or produce. A ten-year plan of development detailing the staff and expenditure required to give full effect to the policy was submitted during the year, and is still under consideration.

Even before the War, but particularly during its preoccupations, inadequate staff has resulted in farming encroachments in reserves; so much so that a certain area of previously reserved forests has now been lost. It is said that as opportunities begin to increase for the necessary stock-taking, it has become depressingly obvious that only a much increased protective staff, firmer deterrents by adequate penalties in the courts and a more rigorous attitude on the part of Government in its reservation policy and practice will check these alarming forest depredations. Among other losses of forest, the Benin Native Administration has had to excise 396 sq. miles which have been so much farmed as to be no longer productive forest. In this connexion a remark is noted by the Conservator of Forests, N.E. Circle, on revisiting the area of the Benin Forest where he had practised sylviculture for some years. "I should like to place on record that I have never seen such extensive forest destruction anywhere to compare with that which has taken place in the unreserved forests of Benin Division during the last ten years. It is indeed fortunate that more than 50% of the forests of the Division have already been reserved. Forest reserves scarcely require to be demarcated now, because they stand out so prominently in the landscape." Other considerable excisions of so-called forest reserves have had to be made in other parts of Nigeria. The report states that: "The reserves, approved many years ago, have in numerous cases not been clearly demarcated and described, and they are steadily being whittled away by the encroachments of farmers. Persistent and continuous efforts to consolidate what remains of the forest, which is essentially the last local source of timber and fuel for a rapidly increasing population, have consistently failed. They will continue to fail if the Department cannot obtain administrative support in resisting the truculent demands of the improvident cultivators. There is admittedly very definite land hunger in this Province, but the relinquishment of all forest land for agriculture will not relieve the pressure for more than a few years, while the production of timber and fuel on land degraded by continuous cultivation and incapable of producing food will then be difficult and expensive."

In the Report for the Forestry Department, Nyasaland, to the end of December, 1945 (Zomba: Gov. Printer, 1946), it stated that the activities of the Department during the year were mainly devoted to maintenance and consolidation of progress already achieved. Proposals for planting schemes in various native areas, mainly for firewood production, were considered by several district development committees, and in most cases endorsed. It is thought that such short-term schemes can usually be financed either by native treasuries or by grants from the local native development and welfare fund. On the other hand, long-term schemes in native areas for the production of major timber will generally require assistance from funds provided under the Colonial Development and Welfare Act, 1945. A pre-requisite, however, for all further forestry development is an increase in the European staff and a local school for training Africans in forestry. An urgent need is to impress on the large African population the principle that payment will have to be made by the people for the ultimate produce derived from forest plantations, and that for the large majority of village communities the only alternative to planting schemes is for them to maintain adequate village forest areas (natural woodland) from which produce may be taken free of charge in return for the free communal labour given in the protection and simple management of the areas.

A committee was set up by Government to make recommendations concerning the legislation which is required to ensure the conservation and improvement of the natural resources of the Protectorate. Recommendations were submitted to Government in the form of a bill introduced at the session of the Legislative Council held in December. The proposed legislation has an important bearing on forest policy, and is greatly welcomed by the Forestry Department.

An interesting item of information of possibly considerable value in the future is contained in the following extract: "Certain areas of the Rift Valley escarpment in Dowa and Dedza district are assuming an increasing importance as a source of bamboos for commercial purposes, the manufacture of tobacco baskets being one of the main items. In order to effect greater control over this trade a bamboo market was established by the Department at Mvera on the Dowa escarpment, and its success was reflected in a great increase in sales of bamboos from the region. It is hoped to set up bamboo markets at other centres. Villagers, of course, come from afar to these escarpments to take bamboos free of charge for their own domestic requirements. Very large numbers of dead bamboos, following a gregarious seeding, are available for cutting in Mua-Livulezi forest reserve near the railway in Dedza district. Local demand is only small and undoubtedly there is scope here for commercial enterprise."

The Administration Report to the end of 1945 of the Conservator of Forests, Trinidad and Tobago (Gov. Printer, Trinidad, 1946), makes interesting reading. In some ways Trinidad has made considerable progress as compared with other forest services under the Colonial Office; not the least, perhaps, in the fact that a number of the forests of the country are under 'working plans' which provide some form of elementary yield control; and even in more or less inaccessible reserves of the Northern Range, which are not yet under working plans, girth limits are in force wherever exploitation takes place. Further, all 'working circles' subjected to concentrated regeneration are governed by working plans. The main factor which is brought about by this position is that the amount of excessive war fellings made during the last seven or eight years will be known and, if necessary, future exploitation regulated in the areas which have suffered, just as is the case in India. This reflects considerable credit on the forest administration of the Colony and the Colonial Government. There are one or two matters, however, in which the Forest Department does not appear as yet to have found itself. It appears to have come to the conclusion that imports of a certain type of forest produce will always be necessary, owing to the fact that exploitation of tropical forest is very costly, and that even the mora forests do not appear to offer great prospects as had once been hoped. On these subjects the report states as follows:

"Whilst the utilisation of local lumber generally has not yet reached the maximum production permissible, for supplies of properly seasoned lumber cut to a variety of standard dimensions, the Colony is dependent upon imports mainly of pitch pine, white pine and douglas fir. No supply of this type of local lumber is available other than small stocks held by furniture makers and private persons for their own use. Adverse factors such as the high cost of exploitation due to low volume production per acre, high loss in conversion of tropical woods, and high cost of labour in relation to skill and output render it unlikely that any such supply from the natural mixed forests could compete with imports. Expert opinion differs as to the economics of intensive exploitation of the mora forests, adverse factors being a high conversion wastage and the refractory nature of mora as a timber. The Colony is likely, therefore, to be dependent upon imports for the higher grade building market until the regenerated forests commence to yield regular supplies of timber at a high rate of volume per acre and consequent low cost of exploitation. Much more intensive exploitation of the forests could, however, be secured by the production of veneers for plywood manufacture. Before this can be undertaken, however, it is necessary to be sure of an adequate supply of raw material, which in turn depends upon how many of the local species will veneer satisfactorily."

In connexion with the introduction of the rotary saw or peeler of the plywood mill into the exploitation of the tropical forest question, it by no means appears necessary that a large percentage of the species of timber in the forest should be capable of peeling; it is not only the veneers from the more valuable tropical species that count, but also the poorer class timbers which are peeled to form the inner sheets; the veneers, of course, only occupying the outside. In any event, testing for peeling purposes of a certain number of the forest species should prove comparatively easy, as they could be sent to the Forest Products Research Station at Princes Risborough, or possibly to one of the United States research institutes. This would appear to be a practical piece of work which should be given early precedence.

Underlying most of the forestry reports from the British Empire at the present time is the recurrent statement stating that the departments are very much under-manned, and that really important work which should be put in hand to secure future progress must be held up until trained staff in sufficient numbers is available.

MUSICAL ACOUSTICS

CONFERENCE AT LIÈGE

In connexion with the recent celebrations of the centenary of the Faculty of Applied Science of the University of Liège and of the Engineers' Association connected therewith, a conference of persons interested in musical and dramatic acoustics was held during September 4–5 in that city. The sessions were held under the presidency of F. Dacos, and the arrangements were in the hands of F. Monfort. They consisted of five lectures by specialists in various aspects of the subject, followed by general discussions in which both men of science and musicians took part.

M. Fouché (Istambul) dealt with the theory of wind instruments. The natural frequencies of columns of air of various types—pipes with side-holes, partially stopped pipes, etc.—are worked out using the analogy with electrical circuits, the 'end-correction' appearing as a form of radiation resistance. For reed pipes the resonant frequencies of the system, reed plus column of air, are calculated and the results discussed in the light of the intonation of instruments like the clarinet. It was pointed out that these problems date back to some experiments performed by the brothers Weber in 1827.

G. van Esbroeck (Ghent) contributed a paper on the history of musical scales. He pointed out that it is not the ear which has dictated the series of tones which an instrument with fixed notes is made to produce; on the contrary, the tuning of such instruments has conditioned the education of the 'musical ear'. Thus our present scales are based on the Pythagorean tuning of the cithara, a stringed instrument of the ancient Greeks. The demands of key modulation, however, have forced a compromise with just intonation in the form of tempered scales. In the discussion that followed, it was pointed out that singers and players on free-note instruments like the violin use individual scales partly to suit the context or line of music and partly as a result of their musical education.

E. G. Richardson (Newcastle-on-Tyne) outlined the theory of coupled vibrations and of transient phenomena in the production of tone by musical instruments. The action of the hammer on a pianoforte string may be likened to the closing of an inductive switch in a primary electric circuit of which the secondary is a cable. The flute and the flue pipes of organs represent coupled systems in which the exciting member (the edge tone at the mouth) is very strongly damped in comparison with the other (the air column), whereas in an organ reed pipe, and still more in the human voice, the reverse is the case. In the first few milliseconds after the excitation of such a system, transients are set up, the wave form of which may be quite different to that of the steady state. The lecture was illustrated by oscillograms made by Dr. Richardson and his students.

L. Canac (Marseilles) described his work on the acoustics of open-air theatres. Tests of audibility of nonsense syllables have been made in the Roman theatres of Provence and in open country of similar rising contour. The theatre at Orange, in which the majority of the tests were made, has the stage complete with wall. Contrary to what has formerly been held, this backing wall does not act as a reflector to add intensity to the actor's voice but is so disposed, with much ornamental excrescence, to act as a diffusing screen; in fact, to simulate the conditions of the open air. This was confirmed by experiments on audibility at the theatre of Vaisons, where though the wall behind the stage has not survived, one can now hear better than at Orange, and by laboratory experiments in a model section, using ripples or supersonic beams to exemplify the diffusing properties of the irregular wall surface. Whatever the original intention, the actual function of the backing wall was, in Prof. Canac's opinion, to act as a screen to cut off street noise.

P. Fouché (Paris) gave a general account, from the scientific point of view, of the present state of the study of phonetics. The physicist plays his part by determining the relation between the timbre corresponding to different vowels and the shape and natural frequencies of the buccal cavities. The existence of fixed pitches (*formants*) corresponding to each vowel sound at whatever pitch it may be enunciated is now well established. The physiologist is concerned to measure the muscular effort required to enunciate and to maintain a speech sound—the latter is not constant but diminishes while the physical intensity remains steady. Psychology enters too, for the speaker often has a different 'feeling' for the rate at which he is using energy from that indicated either by muscular measurements or by a microphone measuring physical intensity. M. Fouché urged that the æsthetic aspects of speech should not be ignored. There is a beauty of language as well as a beauty of literature.

This concluded the discussions, but a visit was paid by those taking part in the meetings to the International Exhibition of Scientific Research and Industry, also held to celebrate the centenary, where of special acoustic interest was an electronic model of the ear, built and demonstrated by Dr. Coppée. This consists of a microphone connected through a number of filter circuits (to represent the resonant properties of the inner ear), each terminating in a thyratron and a flash lamp. The latter simulates the property of nerve fibres by which loudness is measured in terms of the *number* of messages passing per second to the brain. Thus, if one holds near the microphone a sounding tuning-fork of a frequency corresponding to that of one of the resonant circuits, the corresponding bulb begins to flash, and flashes become more frequent as the fork is brought nearer. The apparatus shows many other features of the sense of hearing. Gramophone records of music heard through the ear of a cat were also played.

At the final session, it was unanimously agreed that those present should form the nucleus of an international conference on acoustics generally, which should be called together every few years and held in a number of European centres in succession. The honorary liaison secretary for this purpose is M. F. Monfort, jun., 32 rue de France, Verviers, Belgium.

DANISH MARINE BOTTOM INVERTEBRATES

A RECENTLY published handsome volume*, dedicated to the memory of C. G. J. Petersen, director of the Danish Biological Station for many years, is in the best tradition of Danish oceanographical research, and is a tribute to the undaunted temper of the Danish people, who kept alive the spirit of learning, although surrounded by their enemies.

Petersen and Boysen Jensen had published during 1911–15 their "Animal Communities of the Sea Bottom", dealing with the charting of the fauna of the ocean bed from the Baltic to the Skagerrak by means of the newly invented Petersen grab. It was intended to follow this up by a study of the breeding habits and young of the bottom communities in relation to their importance as food for fishes, but between the Wars attention was diverted to investigations on the fish themselves. Dr. Thorson and his collaborators, many of them well known in the zoological world, began in 1936 an intensive study of the Danish marine fauna, but, "instead of concentrating on the young bottom stages", as Petersen did, have attempted "to trace the species back to the planktonic larval stages". It is here that our knowledge was deficient, yet research from the faunistic, economic or ecological points of view necessitates recognition of the species to which the pelagic larvæ belong. Despite the painstaking work of Mortensen on larval Echinoderms, Lebour on Molluscs and Crustacea and D. P. Wilson on Polychætes, most of us get no further than identifying an *Auricularia* larva, a Nudibranch egg ribbon, a zoœa larva or a Spionid metatrochophore. At first, then, much of Dr. Thorson's work was analytical. He must either rear the larvæ from eggs, as has been done so successfully at Plymouth, or trace the stages back to younger and younger larvæ, sketching every 'unknown' alive, in the hope that some day its place in the series will be found and its parents determined. Since these early stages are so sensitive to their environment, it is important to collect them in their own water, and to record temperature, light intensity, salinity, pH, food conditions and enemies. When all this has been done a synthesis from an ecological point of view can be attempted, involving all stages in the life of the animal and its community. "The whole survey," writes Dr. Thorson, "has been carried out in our leisure hours, and enabled us to combine the scientific work with splendid summer holidays."

The plan of campaign was to take vertical plankton hauls at metre intervals, from near the bottom to the surface, in fixed localities, every fortnight throughout the year. Two main sites were chosen, one off the island of Ven (Swedish) and the other at Helsingør (Danish). The former was used until 1941, after which date, owing to the War, the work was transferred to the Danish station. The net hauls were examined as soon as possible by a team of workers sorting, counting, sketching, recording and, if possible, identifying the species of animals. During the summer pump hauls were taken by pumping 200 (later 100) litres through a No. 12 plankton sieve, starting a few centimetres above the bottom, and repeating at metre intervals, so that nineteen samples were taken from the 20-metre depth of water. The advantage of this procedure was that the individual samples were transported to the laboratory in water from their own depths. Rearing of the larval stages was carried out in aquaria in the laboratory, and by means of 'bottle collectors' invented for the purpose. These were left submerged in the open sea, at the depth to which certain organisms were accustomed, for six weeks at a time, and then hauled up for inspection. The cage collectors used by Smith in Great Britain were found unsuitable owing to variations in temperature and salinity in Danish waters. The bottle collector is like an inverted bell jar, with a stopper at the lower end, protected at the sides by a jacket of pieces of cork held together by netting. It is anchored by stones to the required depth, and is marked by a float on the surface. This open apparatus collects its own sea bed for the delicate larvæ, from the rain of detritus from above, and experience shows that the larvæ are closely adapted to suitable surroundings, dying rather than metamorphosing if the right substratum is not available. The water in the bottle collects the swimming stages. Moreover, after being hauled up, the bottles can be placed on racks and kept as small aquaria. In one locality young bottom stages of seventy invertebrates were secured at a depth of 16 m.

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* Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie: Plankton. Bind 4. No. 1. Gunnar Thorson: Reproduction and Larval Development of Danish Marine Bottom Invertebrates, with special reference to the Planktonic Larvæ in the Sound (Øresund). Pp. 523+199 plates. (København: C. A. Reitzels Forlag, 1946.)

The results of these investigations showed that the dominant groups in the Sound plankton are Lamellibranchs (57·3 per cent), Prosobranchs (12·5 per cent), Polychætes (10·9 per cent) and Echinoderms (1·9 per cent). There is a high percentage of Cyphonautes larvæ (12·9 per cent), leaving only 4·5 per cent for all other groups.

Dr. C. B. Jørgensen contributes the section on Lamellibranch larvæ, and was able to identify twenty-three species, the most interesting of which were those of *Teredo* and the two species of *Montacuta*. Sixty-one Prosobranchs are known in the larval stage, and of these sixty have a long pelagic life. They are mostly phytotrophic and form the food of herring, mackerel and many invertebrates. About half the 142 species of bottom Polychætes can be identified in the larval stage, and their success in evading capture by predaceous animals is due to their armour of bristles. Many feed on the larvæ of Lamellibranchs. The percentage of Echinoderm larvæ appears small, until it is realized that these well-known larvæ cannot endure changes in salinity and temperature, and having no hydrostatic apparatus are unable to adjust themselves in depth when an infiltration of less saline waters from the Baltic floods the upper waters of the Sound. Dr. Mortensen considers that the parent stock on the bottom is recruited, not from the larvæ in the Sound itself, but from the large swarms of the Kattegat. He found also that the reproductive-rate of these migrants was less in the new habitat. This relation between spawning, larval survival and ecological conditions might be followed up around the shores of Britain in an attempt to explain anomalies of distribution.

Two life-histories that are of special interest are those of *Philine aperta* and the Holothurian *Psolus phantopus*.

In the final discussion many valuable generalizations emerge. Evidence goes to show that the larvæ are evenly distributed through the water masses, rarely swarming. In two years only three larvæ of *Strongylocentrotus drœbachiensis* were collected. Is this species, therefore, rare? Yet, if evenly distributed, there would be two and a half milliards in the area. What, then, must be the population of 'common' forms? Dr. Thorson works out that *Littorina littorea* would have twelve thousand milliard and *Mytilus edulis* four thousand five hundred milliard larvæ.

The distribution of the larvæ throughout the year enables one to work back to the spawning periods. July has the maximum for all types of larvæ in the Sound, but there are lesser peaks in spring and winter. The minimum is in the late autumn. Compared with fjord conditions, spawning is spread over a long period, not concentrated into a late spring and early summer peak as in the fjords. In the Sound there is a drift of larvæ from the Baltic northwards to the Kattegat, bringing impoverished specimens from the less saline waters. The reverse stream, from the Kattegat southwards, is much richer in individuals. There are also the larvæ developing from the spawn of animals living on the bottom. Analysing these three sources, Thorson found that the Baltic stream from May onwards brings chiefly the larvæ of *Littorina littorea* and other Prosobranchs, the bottom fauna of the Sound produces non-pelagic larvæ or larvæ with a short pelagic life (for example, *Serpula*), and the parents in the Kattegat provide 50 per cent or more of the whole stock in the Sound, mostly larvæ with a long pelagic life. As an ecological area, therefore, the Sound supplies very different data from those obtainable in either arctic or tropical regions, where the larvæ have mostly a short pelagic life; and in the temperate zone it is the high proportion of larvæ with a long pelagic life which provides food for the fishes of economic importance. Moreover, this is the group that shows the greatest fluctuation in numbers from year to year.

To sum up, Dr. Thorson's book is a valuable contribution to both analytical and synthetic aspects of the fauna of a marine area. We in Britain can learn much from his work and his methods, and not by any means least from his clear, smoothly flowing English and delicate, accurate drawings.

There is a summary at the end of each section, and the final summary is printed also in Danish. An exhaustive bibliography and index are appended. The book is well produced and printed, but its limp covers will soon need replacement in libraries.

N. B. EALES

FORTHCOMING EVENTS

Monday, December 1

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

Tuesday, December 2

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p.m.—Dr. K. W. Richmond: "Modern Trends in Hydrogen Peroxide Application".

SOCIETY OF DYERS AND COLOURISTS, HUDDERSFIELD SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, at Field's Café, Westgate, Huddersfield), at 7.30 p.m.—Dr. W. Baird: "Modern Developments in Synthetic Detergents".

Wednesday, December 3

PHYSICAL SOCIETY, COLOUR GROUP (in the Lecture Theatre of the Geological Museum, Exhibition Road, London, S.W.7), at 3.30 p.m.—Mr. J. Pryce-Jones: "Ultramarine—Natural and Synthetic".

HISPANIC AND LUSO BRAZILIAN COUNCILS (at Canning House, 4 Upper Berkeley Street, London, W.1), at 5 p.m.—Mr. Kenneth G. Grubb: "The Great British Explorers of the Interior of South America".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. C. Macnamara, Mr. A. B. Howe and Mr. P. A. T. Bevan: "The Design and Operation of High-Power Broadcast Transmitter Units with their Outputs Combined in Parallel".

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Dr. George Gibson: "Modern Distribution of Industrial Activity in the North-West Region".

Society of Public Analysts and other Analytical Chemists (joint meeting with the Food Group of the Society of Chemical Industry, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Discussion on "The Occurrence, Physiological Importance and Estimation of Metallic Contaminants in Foodstuffs".

Thursday, December 4

Chemical Society, Sheffield Section (joint meeting with the Sheffield University Chemical Society, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. G. R. Clemo, F.R.S.: "The Bearing of the Isotopes of Carbon, Hydrogen, Oxygen and Nitrogen on Organic Chemistry".

Institution of Electrical Engineers (joint meeting with the Acoustics Group of the Physical Society, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. W. G. Radley: "Speech Communication under Conditions of Deafness or Loud Noise".

Chemical Society, Nottingham Section (in the Chemistry Lecture Theatre, University College, Nottingham), at 6 p.m.—Scientific Papers.

Illuminating Engineering Society, Manchester Centre (in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. W. Imrie-Smith: "Industrial Lighting".

Institution of Mechanical Engineers, Graduates' Section (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. K. M. Fantom: "Electronics for the Mechanical Engineer".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Sir Ian Heilbron, F.R.S.: "Recent Developments in the Vitamin A Field" (Pedler Lecture).

Society of Chemical Industry, Chemical Engineering Group (joint meeting with the Bristol Section of the Society of Chemical Industry, at Bristol).—Mr. A. Forster and co-authors: "The Manufacture of Tetryl by Continuous Nitration".

Friday, December 5

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Economics of Metering" (to be opened by Mr. M. Whitehead).

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. E. A. Watson: "Fuel and Combustion Systems for the Aero Gas Turbine".

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Prof. D. M. S. Watson, F.R.S.: "Fossilization".

Royal Statistical Society, Industrial Applications Section (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. E. C. Fieller: "The Mathematics Division of the National Physical Laboratory, with particular reference to Statistical Methods".

Society of Chemical Industry, Manchester Section (joint meeting with the Local Sections of the Chemical Society and the Royal Institute of Chemistry, in the Lecture Hall, Albert Hall, Manchester), at 6.30 p.m.—Sir Wallace Akers: "Industrial Uses of Atomic Energy".

Manchester Statistical Society, Industrial Group (in the Society of Architects' Room, Textile Institute, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. J. Morley: "Some Statistical Experiments in the Steel Industry".

Society of Instrument Technology, Midland Section (at the Chamber of Commerce Buildings, New Street, Birmingham), at 7 p.m.—Mr. V. A. Hughes: "Some Examples of Instrumentation in Modern Research".

Saturday, December 6

British Mycological Society (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon.—Annual Meeting; at 2 p.m.—Prof. C. G. C. Chesters: "Concerning Fungi Inhabiting the Soil" (Presidential Address).

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the University, Reading), at 3 p.m.—Prof. E. A. Guggenheim, F.R.S.: "The Atomic Nucleus".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant in the Chemistry Department—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9 (December 1).

Assistant Laboratory Technician in the Histological Laboratory—The Registrar, The University, Liverpool (December 6).

Chemical Pathologist in the Department of Pathology and Bacteriology—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff (December 6).

Technical Assistants in the Pasture Research Branch of the Department of Agriculture and Lands—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (December 10).

Advisory Officer in Crop Husbandry—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (December 12).

Algologist (Scientific Officer) at the Millport Laboratory—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (December 13).

Senior Physicist with experience in textile research, a Senior Organic Chemist with experience in textile research, a Physicist with research experience, though not necessarily in textiles, and a Chemist for physical chemical research—The Director of Research, British Jute Trade Research Association, Bellfield Street, Dundee (December 20).

Junior Observer—The Director, The Observatories, Cambridge (December 20).

Assistant Pomologist, and an Assistant Plant Physiologist, at the Long Ashton Research Station—The Secretary and Registrar, The University, Bristol (December 27).

Naturalist at the Dove Marine Laboratory—The Registrar, King's College, Newcastle-upon-Tyne (December 31).

Travis Research Fellowship in Bacterial Metabolism in the Medical School, University of Otago—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (Otago, December 31).

Research Fellowship for the study of properties of natural and synthetic fibres—The Registrar, The University, Leeds 2 (January 1).

Head of the Applied Nutrition Department—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (January 3).

Assistant Lecturer (Grade III) for the Department of Brewing and Industrial Fermentation—The Secretary, The University, Edmund Street, Birmingham 3 (January 12).

Professor of Physiology—The Secretary, Queen's University, Belfast (January 17).

Lecturer in Diploma Mathematics (Post Matric. standard), a Lecturer in Physical, Organic, Inorganic and Industrial Chemistry and Chemical Engineering, a Lecturer in Diploma Physics (Post Matric. standard), a Lecturer in Electrical Engineering, a Lecturer in Mechanical Engineering, and a Lecturer in Civil Engineering, in the Technical Education Branch of the Department of Public Instruction of New South Wales—The Official Secretary, New South Wales Government Offices, 56–57 Strand, London, W.C.2 (January 25).

Assistant Director, Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 23–25 Soho Square, London, W.1 (January 31).

Lecturer in Geology—The Registrar, University College, Hull (January 31).

Assayer or Chemist with special experience in the analysis of non-metallic and metalliferous minerals—The Secretary, Mianraí, Teoranta, Four Provinces House, Harcourt Street, Dublin.

Lecturer in Histology and a Lecturer in Biochemistry—The Registrar, King's College, Newcastle-upon-Tyne.

Assistant Chief Pharmacist by the Government of Malayan Union for Medical Department, Singapore—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18288.

Research Worker (Junior, temporary) in Chemotherapy and Tropical Medicine at the National Institute for Medical Research—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

Metallurgist by the Ceylon Government for the Department of Commerce and Industries—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N. 14681.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 75: Dielectric Relaxation and Viscosity of Long-Chain Dipolar Liquids. By Adolf Schallamach. Pp. 14. Publication No. 77: A Differential Fourier Method for Refining Atomic Parameters in Crystal Structure Analysis. By A. D. Booth. Pp. 6. Publication No. 78: The Accuracy of Atomic Co-ordinates derived from Fourier Series in X-Ray Structure Analysis. By A. D. Booth. Pp. 16. (London: British Rubber Producers' Research Association, 1946.) [313

Imperial Institute. Annual Report, 1946, by the Director, Sir Harry Lindsay, to the Board of Governors. Pp. 80. (London: Imperial Institute, 1947.) [94

Imperial Cancer Research Fund. Forty-fourth Annual Report, 1946–1947. Pp. 36. (London: Imperial Cancer Research Fund, 1947.) [94

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 197: The Analysis of the Hydrocarbon Gases by Fractional Distillation, with especial reference to Cracked Tar Gases. By R. J. L. Martin. Pp. 36 + 4 plates. (Melbourne: Government Printer, 1946.) [213

Journal de la Société des Océanistes. Tome 1, No. 1, Décembre. Pp. 234. (Paris: Musée de l'Homme, 1946.) 300 francs. [213

Astrographic Catalogue 1900·0. Sydney Section, Dec. −51° to −65°, from Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 18, with Plate Constants for Vols. 21 to 24: R.A. 6^h to 12^h, Dec. −55° to −57°, Plate Centres Dec. −56°. Pp. viii + 119. Vol. 20: R.A. 18^h to 24^h, Dec. −55° to −57°, Plate Centres Dec. −56°. Pp. iv + 33. (Sydney: Government Printer, 1946.) [213

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1946. (Publication 3864.) Pp. ix + 134. (Washington, D.C.: Government Printing Office, 1946.) 35 cents. [213

Smithsonian Miscellaneous Collections. Vol. 106, No. 15: Ladybeetles of the Genus *Epilachna* (Sens. Lat.) in Asia, Europe and Australia. By G. H. Dieke. (Publication 3860.) Pp. iii + 183 + 27 plates. (Washington, D.C.: Smithsonian Institution, 1947.) [213

Smithsonian Institution: United States National Museum. Bulletin 50: The Birds of North and Middle America. Commenced by the late Robert Ridgway, continued by Herbert Friedmann. Part 10. Pp. xii + 484. (Washington, D.C.: Government Printing Office, 1946.) 1.25 dollars. [213

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UNIVERSITY EXPANSION IN GREAT BRITAIN

IN the note on University Policy and Finance in Great Britain which the Vice-Chancellors and Principals Committee issued last July, the need for some overall planning of available resources as between the different universities of Britain was recognized by the official heads of the universities. The first need at the moment is a vigorous defence of the main programme of university expansion, and most important, on lines which will permit the development of teaching and research facilities to a point which will provide for the increase in the number of graduates called for by the Barlow Report and elsewhere. It is no less important that closer attention should be given to the question of exactly how and where that expansion should take place. The Committee of Vice-Chancellors and Principals has already accepted the view that the Government not only has the right but also the duty to satisfy itself that every field of study which in the national interest ought to be cultivated in Great Britain is, in fact, being adequately cultivated in the university system, and that the resources which are placed at the disposal of the universities are being used with full regard both to efficiency and to economy. Furthermore, it believes that the universities may properly be expected, collectively as well as individually, to devise and execute policies calculated to serve the national interest.

From this point of view, the recent conference of the universities of Great Britain (see *Nature*, October 18, p. 522) was disappointing. It is true that it is something that institutions of such strong independence and diversity of age and constitution should have been brought together to discuss common problems ; but it is no less true that what the conference revealed was not a large measure of common purpose but a marked preference for each university to deal with its own problems independently. The universities of Great Britain are clearly unaccustomed to thinking of themselves as a group ; and in spite of many admirable pronouncements from individuals, there is little evidence that the universities as bodies have yet realized that they are, or could be, a single force in the life of the community.

This lack of unanimity had several untoward consequences. It gave a certain air of unreality to the whole proceedings, but especially to those at the first session, dealing with the expansion of the universities. Even with Sir Alan Barlow in the chair, that discussion seemed in a world apart from the world economic crisis ; for no one ventured to face the possible effects of that crisis, direct or indirect, on university expansion, and what revision in capital expenditure would be possible, if called for, with the minimum handicap to expansion.

No doubt if the new Chancellor of the Exchequer, in the midst of his manifold responsibilities, can give any personal attention to the details of capital grants to the universities, they should have no cause to fear unreasonable calls for retrenchment. Sir Stafford

Cripps should be better able than most Ministers to appreciate the importance of the contribution of the universities to the efficiency of British industries and the production drive. But there will be no harm done if the universities are brought to realize that expansion may have to take place by austerity standards in order that the needs and standards of learning may be maintained.

Though expenditure on university education is an outstandingly rewarding investment for the nation, it was unwise for the universities to miss such an opportunity of a united testimony. Moreover, even if the recurrent grants to the universities are unaffected by the crisis, the expenditure, if not the amounts of the capital grants, may be modified. Halls of residence and some other building schemes may have to go lower on the list of priorities. Further, if the targets for increasing numbers are not to be lowered, especially the provision of teaching facilities, any reduction in capital expenditure will require careful adjustment and probably of a type that is almost impossible without close co-operation between the universities.

The conference maintained that the existing planning organisations are adequate, and this was a main reason for the rejection of the proposal for the establishment of a representative universities council. That might be true but for the existence of such independence or non-co-operation as was apparent at the conference. The emphasis placed by the conference on university freedom was, in fact, misplaced. The real dangers to university independence and freedom to-day may lie as much within the universities themselves as outside their gates.

The Vice-Chancellors and Principals Committee has suggested that the University Grants Committee should undertake the task of overall planning and making the necessary surveys of all the main fields of university activity in Great Britain. General recognition of the admirable work which the University Grants Committee has done and continues to do is to be found side by side with two opinions in the universities themselves, as well as outside, whether even the reconstituted Committee will be adequate for its task. The Vice-Chancellors visualize the Committee as surveying the university system and offering advice and suggestions to the universities as it seems fit; but while the Vice-Chancellors admit that they are not in a position to judge finally as to the order in which priorities would best accord with the nation's needs, there must remain the doubt at least in the minds of those outside the universities as to how far a particular university would accept advice and suggestions from the Committee on matters which touch closely local interests or tradition.

Apart from this, there is the view to which *The Economist* has given expression, which regards the University Grants Committee as inherently liable to accept passively suggestions which may come from the universities and the Committee of Vice-Chancellors and Principals rather than take an independent line of its own. Admirable as is the idea of a quinquennial Treasury fund for capital expenditure suggested by the Vice-Chancellors and Principals in their note, it might well be accompanied by conditions designed to ensure that development is in line with national and not sectional requirements, so far as those needs can be foreseen.

It cannot be said, therefore, that the question of the authority and organisation for university development as a whole has yet been finally determined. But while this urgent problem is being considered, it is important that the breathing space which some restriction on capital expenditure affords should be utilized to determine as accurately as possible the quantitative expansion of students which is desirable. The Ministry of Labour and National Service has already set on foot an inquiry to obtain as complete an analysis as possible of the existing distribution in age-groups and subjects of scientific and technical workers in Great Britain and overseas (see *Nature*, Nov. 29, p. 742).

Such surveys are manifestly required to supplement and to particularize the estimates both of the Barlow Report and the Percy Report, which were not entirely complementary; but more will still be required, as was indicated in the more recent Urwick Report, to cover the absorption of arts as well as science graduates in the administrative side of industry. There is room here for further surveys alike by the university appointments boards, the appointments bureaux of the professional organisations and by the Ministry of Labour and National Service; and they should be implemented at once so that their findings are available before the restrictions on expansion likely to be imposed by the general limitation of capital expenditure to £20,000,000 of building within the next five years can cease to be effective.

The survey recently completed by the Federation of British Industries* shows that industry is making a real attempt to formulate its own quantitative demands for research workers and technologists. This survey estimates that about forty-five thousand persons are employed directly on industrial research and development in industry, of whom about ten thousand possess a university degree or an equivalent qualification. These include mathematicians, physicists, chemists, biologists, engineers, metallurgists and others; nearly half are chemists and one third are engineers. Plans for the immediate future, to the end of 1947, indicate that half the firms who replied to the questionnaire will require additional qualified staff amounting to an increase of about twenty-five per cent, and the general trend of the replies indicates that a further increase of the same order will be required for 1948–50. The greatest numerical requirements are for chemists (839) and for engineers (494), but greatest proportional increases are for biologists (167) and physicists (252).

One of the first points that emerges from any such survey is the impracticability of considering university expansion apart from that of the technical colleges. Unless the anomaly in the higher educational system of Great Britain which places the development of universities and of colleges of technology under different Ministers is to be corrected in the near future, some other means of securing the necessary co-ordination must be devised as a matter of urgency. This is shown up even on the side of scientific man-power. With all the limitations of the present colleges of technology, it is estimated by the Parliamentary and Scientific Committee that between them they could have an output of between 5,000 and 7,000 trained technologists and scientific workers a year as against the 3,000 estimated for 1943 by the Percy Committee. This number cannot wisely be doubled without regard to the concurrent doubling of the output of science graduates from the universities, or indeed without regard to the output of arts graduates. At the present moment, as Lord Simon has pointed out, the relatively greater ease of expansion on the arts side of the universities has permitted the output of graduates in arts to rise more rapidly than the output of science graduates, and the problem of employment for arts graduates is already viewed with some concern. Important as it may be that there should be a proper balance between the different faculties in university expansion, there is a serious danger if the output of arts graduates is allowed to exceed to any considerable extent the probable demand for their services. Large-scale unemployment among university graduates has repercussions which are the more dangerous in that they are not immediately visible.

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* Scientific and Industrial Research in British Industry: a Statistical Survey by the Industrial Research Secretariat. Pp. 20. (London: Federation of British Industries, 1947.) 1*s*.

An obvious first precaution is the compilation of reasonably accurate estimates of demand, and in this urgent task the Higher Appointments Department of the Ministry of Labour and National Service and the Technical Personnel Committee should receive every assistance that the professional organisations and the university appointments boards can give. However, it also raises more fundamental questions as to the purpose and content of university education itself, and whether in general it tends to be standardized too much in terms of the past. Lord Lindsay of Birker has stated that businesses are more and more going to the universities not just for men trained in the technical aspect of business but for men trained in problems of management, welfare and the like; and that local education authorities confronted with the expansion of the social services are asking more and more for men trained in the universities to deal with all kinds of problems concerned with the social services. Lord Simon also suggested that there are many administrative positions in which university men trained to bring imagination and breadth of view to bear on a situation may provide something that is often lacking in branches of industry and of local government. Even if the traditional avenues for the employment of arts graduates were not contracting rather than expanding, we are brought here face to face with the question whether the arts degree is to be regarded as in some measure a preparation for employment rather than for life.

The same fundamental issues were discussed at the recent Dundee meeting of the British Association in the discussion on the education of the man of science, and there is much to be gained if the different aspects are considered not in isolation but as particular aspects of one problem. Closer consultation between the different parties concerned and further exchange of views between competent and representative bodies will be required; and also some measure of experiment with fresh measures is necessary. Lord Lindsay indeed urged, as one reason for the establishment of a new and independent committee to consider the long-range problems, that the University Grants Committee, by practice and constitution, is not necessarily the best body to review the whole framework of higher education with the idea, perhaps, of revolutionary change.

There is no question of the importance of expanding the universities of Britain, and the imperative need for the universities, collectively rather than individually, stating the case for expansion and indicating quantitatively so far as possible how that expansion is to be planned in relation to available resources. Temporary retardation of the rate of expansion may be no disadvantage if the opportunity is seized for experiment and for fundamental thinking about the issues involved. There must also be greater readiness and determination to deal with the problems of specialization and of departmentalism, a readiness to accept new groupings rather than the traditional arrangements of subjects, and to work out, if necessary, new means by which standards of intellectual discipline can be maintained and inculcated.

These are not tasks which can be left to any one body, whether it be the University Grants Committee, a universities advisory council, or a new Royal Commission. They require the close co-operation of those engaged in university teaching, research or administration, school teachers, professional associations, industrial scientists, administrators and many others. Above all, the tasks demand the sustained interest of all those individual citizens who, whether university graduates or not, have seen some vision of what is at stake, and who realize how much depends on the universities providing not merely trained intellects but also men and women of personality and character.

MICROPALÆONTOLOGY IN GEOLOGY

Principles of Micropalæontology

By Martin F. Glaessner. Pp. xvi+296. (Melbourne: Melbourne University Press; London: Oxford University Press, 1945.) 45*s*. net.

THE last few decades have seen the rise of micropalæontology to a position of considerable importance in geology, particularly in the quest for oil. The publication of Dr. Glaessner's book is therefore a welcome event; and its production in this handsome form during the recent World War reflects credit upon those responsible for its get-up.

Although it was the academic geologists who first realized the scientific value of microfossils, we owe the main developments in this field to the applied geologists, and particularly to the palæontologists employed in the oil and coal industries. A notable exception to this statement is provided by the remarkable output of literature on Pleistocene and recent spores and pollen which has enriched our appreciation of plant distribution and chronology, of climatology and orogeny, and even of prehistory and archæology.

The book has grown out of a series of lectures given by the author in the University of Moscow, and the author makes acknowledgments (*inter alia*) to the Anglo-Iranian Oil Company and the Standard Vacuum Oil Company (New York) for their interest as sponsors for the work.

The treatment of the subject is dominated by the point of view of the oil geologist, for whose purpose the Foraminifera are—and are likely to remain—by far the most important microfossils, not only because of their great vertical range (Cambrian to Recent) and wide dissemination in the marine strata, which form the greater part of the sedimentary record, but also because they show fine morphological distinctions which can be closely dated in geological time.

The text is divided into three parts. In Part 1, after a brief historical introduction (Chap. 1, pp. 3–6), the author gives a cursory treatment (Chap. 2, pp. 7–32) of different groups of animals which are represented as microfossils; also of the flagellates, diatoms and bacteria. The stratigraphical value of plant microfossils, especially of spores and pollen, is fully recognized; but as their study is a highly specialized branch of micropalæontology the author makes no attempt to deal with it in any detail. Chap. 3, pp. 33–57, which should be read with a brief appendix (Chap. 10, pp. 237–242) deals with the practical details of collecting and preparing, preserving and studying microfossils. Although mainly intended for the use of those working on the Foraminifera it contains practical hints which the palæobotanist, too, would find useful. There is no mention of that time-honoured formula of Schulze (maceration with nitric acid plus potassium chlorate, followed by alkali treatment) which has served the palæobotanist so well. Freshwater Tertiary sediments examined mainly for plant microfossils are known to have yielded occasional chitinous fragments of animals (chiefly insects and mites). This technique is perhaps worthy of trial on marine rocks which contain animal remains having chitinous parts, for example, trilobites, arthropods, etc. If critically studied on the lines of plant cuticles, animal chitins may be expected to yield further data of practical as well as purely taxonomic value.

Part 2 (pp. 58–194) gives in three chapters a detailed account of the palæontology of the Foraminifera, with an introduction of ten pages on the structure of the living organism. The classification of the group is discussed in detail, with numerous illustrations and analytical charts which bring out graphically the more important facts relating to the morphology, palæoecology, stratigraphical distribution and phylogenetic relationships of the different groups of Foraminifera. In an appendix (pp. 243–252) there is a synopsis of a revised classification of the group and of the geological ranges of the more important genera.

Part 3 is devoted to stratigraphic micropalæontology. In Chap. 7 (pp. 197–212) the sequence of microfaunas from Cambrian to Tertiary is reviewed, and Chap. 8 (pp. 212–226) treats at some length of the correlation of strata, both local and regional, on microfossil data. The role of microfossils in oil geology is explained in Chap. 9 (pp. 227–235), with special reference to the main oil-producing regions of the world.

There is a voluminous bibliography covering thirty pages, classified chapterwise, followed by an index of fourteen pages and a table giving the standard stratigraphical scale, conveniently placed on a folder at the end of the book.

As stated, the work is chiefly intended for the student of Foraminifera in the search for oil, and the main body of the volume could do very well as an advanced text-book on the Foraminifera. For these purposes, evidently, the book is bound to be of the greatest value.

In the preface the author expresses the hope that a handbook covering the whole field of micropalæontology may at some future time be produced by the co-operation of specialists in different branches of the science. It is much to be hoped that this suggestion will fructify, and bring together in a handy form the vast and rapidly growing literature on spores and pollen both for the use of the academic student and of those engaged in the practical problems of lignites, peats and coals, and oil.

It has recently been shown[1] that in freshwater sediments which are devoid of Foraminifera, for example, in the great Tertiary oil-bearing series in Assam (until recently regarded as practically unfossiliferous), plant microfossils have a potential stratigraphical value parallel to that of the Foraminifera in the case of marine sediments. The value of plant microfossils in structural geology has also been demonstrated in a striking manner by confirming the idea of a regional thrust in the Salt Range which has brought the Cambrian and other Palæozoic strata in the Punjab so as to overlie the Eocene Saline Series[2]. The use of pollen analysis in the investigation of glacier movements is a fine illustration of the possibilities of this technique, which Volkmar Vareschi[3] has ingeniously laid bare.

The science of micropalæontology strides forward with the vigour of its youth: the number of specially trained workers and specially equipped laboratories engaged in this field all over the world bear witness to its interest and importance. Dr. Glaessner's book will provide a further stimulus to this activity.

All students of geology, and oil geologists in particular, will be grateful to the author for this valuable presentation of a subject of increasing scientific as well as practical interest.

B. Sahni

[1] Work done at the Institute of Palæobotany, Lucknow, for the Burmah Oil Company (India Concessions): summary in "Palæobotany in India", 6 (*J. Ind. Bot. Soc.*, 1947).

[2] Second Symposium on the Age of the Saline Series, *Proc. Nat. Acad. Sci. India*, **17**, 1-1, 29–257 (April 30, 1947).

[3] "Die pollenanalytische Untersuchung der Gletscherbewegung", Veröffentl. d. Geobot. Inst. Rübel in Zürich, **19** (1942).

RECENT PROGRESS IN GENETICS

Advances in Genetics

Edited by M. Demerec. Vol. 1. Pp. xvi + 458. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 7.50 dollars.

If the first volume may be taken as a fair sample of what is to come, many biologists besides geneticists proper will extend a warm welcome to the new series of "Advances in Genetics", edited by Dr. M. Demerec. No one nowadays can be confident of accomplishing the Sisyphæan task of keeping up with the literature, except within a very narrow field, which can scarcely comprise more than one section of such a broad discipline as genetics. Yet it becomes clearer every day that even sciences which were conventionally considered quite distinct do, in fact, throw revealing gleams of illumination on to one another, and may suddenly coalesce in the most unexpected, but fertile, unions. In these circumstances, a vital part is played by critical summaries of recent progress, detailed enough to reveal what is actually known and what is merely guessed, yet concise enough to deal with an important topic in a compass which the busy specialist in other fields can find time to absorb. In the past, there have been few such reviews on genetical subjects; this lack the new series is designed to fill.

The first volume covers a wide range, dealing with both botanical and zoological topics. The authors are all American, and could scarcely be otherwise, not only because American biologists have made genetics one of their favourite fields and have taken an undoubted lead in its recent development, but also because their work was considerably less interrupted by the War than that of any other country. It is certainly symptomatic of one of the main trends of present American thought in genetics that a majority of the articles deals explicitly with evolutionary problems. Thus Babcock summarizes the very extensive work on speciation in the genus *Crepis*; Gordon discusses speciation in fishes, with especial reference to the distribution of genes in some wild populations of *Platypœcilus*; Mangelsdorf writes on the origin of maize and Stephens on that of cotton; Stebbings deals with the different types of natural and synthetic polyploids; and Spencer gives a full account of the investigations which have been made on the mutant genes occurring in wild populations of *Drosophila* species.

The unprejudiced reader cannot help admitting, perhaps with some disappointment, that no other organism can begin to compete with *Drosophila* as a betrayer of Nature's genetical secrets. The story which Spencer unfolds is restricted to one special aspect of our knowledge of Drosophilid evolution-in-the-making; he describes only the distribution of mutant genes, and omits, for example, the massive work of Dobzhansky and Wright on the natural chromosome inversions within a single species, the studies of Sturtevant, the Texas group under Patterson, and others on systematics and chromosome morphology, as well as the recent work on mating barriers and infertility mechanisms within the genus. But one has only to compare Spencer's review with that of Gordon on fishes to realize how much fuller is our understanding of the insect; and if the cytological part of the *Drosophila* story had been included it would be found not inferior even to the body of information which has been collected about such plants as maize and *Crepis*.

Of the non-evolutionary articles, two are agricultural: Attwood on the breeding of forage crops, and Shrode and Lush on cattle. Irwin gives an account, perhaps rather too condensed, of recent work in immunological genetics, which includes a welcome summary of his own studies on the inter-specific antigens in doves. Perhaps the most generally interesting of these articles, and one of the highlights of the book, is a long review by Sonneborn of the recent studies on Protozoan genetics, conducted mainly under his guidance. The discovery of the system of 'mating types' within the varieties of *Paramecium aurelia* made possible an analysis by means of cross-breeding, the first result of which was to clear up many obscure points in the general reproductive biology of this classical organism. Very shortly, however, results emerged which were of much more profound significance for biology as a whole. In the best analysed varieties of *Paramecium*, inheritance of many, if not all, characters is primarily through cytoplasmic factors. A considerable amount has already been accomplished towards elucidating the extraordinary relations between the reproduction of these factors and that of the genes to which they are related; and by very ingenious methods of controlling the relative rates of reproduction, and the amounts of cytoplasm passed between the two individuals in conjugation, it has been possible to estimate that each cell may contain some 200–300 particles of one of the cytoplasmic factors. The importance of this line of work for our understanding of the relations between gene and cytoplasm, and thus for our theories of the most fundamental aspects of cell physiology, can scarcely be over-estimated.

C. H. WADDINGTON

BESSEL FUNCTIONS IN BULK

Tables of the Bessel Functions of the First Kind of Orders Zero and One

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 3). Pp. xxxvii+652.

Tables of the Bessel Functions of the First Kind of Orders Two and Three

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 4.) Pp. ix+652.

Tables of the Bessel Functions of the First Kind of Orders Four, Five and Six

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 5.) Pp. xi+652.

Tables of the Bessel Functions of the First Kind of Orders Seven, Eight and Nine

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 6.) Pp. ix+648.

(Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1947.) 55*s*. net each volume.

THE Computation Laboratory of Harvard University is equipped with an *IBM* automatic sequence controlled calculator, the construction and operation of which are described in Volume 1 of its *Annals* (see *Nature*, **158**, 567, Oct. 26, 1946). It was built with Bessel functions in the forefront of its programme, but has seen some war service. Now the calculation of these functions is—and despite its speed and ability to work 168 hours per week is likely for some time to remain—its 'base load'.

The four volumes before us are the first-fruits of its labours in this field. They contain values of $J_n(x)$ for $n = 0(1)9$ and $x = 0(0{\cdot}001)25(0{\cdot}01)99{\cdot}99$ (it is absurd that place could not be found for $x = 100$). The values for $n = 0, 1, 2, 3$ are given throughout to eighteen decimals, while those for higher values of n are given to ten decimals only.

The tables are entirely new, and are independent of all previous computation in this field. The 18-decimal values in volumes 3 and 4—or more precisely the 23-decimal values upon which they are based—form the foundation for subsequent volumes. In computing these use was made, for the smaller values of x, of the ascending power series (more accurately the Horner process applied to the polynomial which is the series truncated at a suitable term); but a change to the asymptotic series was made when x became large enough for this to yield the desired accuracy. The 10-decimal values in volumes 5 and 6 have been computed by a straightforward application of the recurrence formula. Details of the formulæ used, and of the elaborate checks applied, are given in an interesting introduction to volume 3. The machine prints its results by means of an electromatic typewriter, and it is these printed results which have been reproduced by photo-lithography, so that it is extremely unlikely that any errors will be found.

No direct provision is made to facilitate interpolation, but formulæ involving differences, and their Lagrangian equivalents (same order, different arguments), are given in the introduction to volume 3, while formulæ depending on the Taylor series, again reduced to Lagrangian form (same argument, different orders), are given in the introduction to volume 5.

The intention is to proceed with the computation of $J_n(x)$ for the same range of x as in the present volumes, for integer values of n up to and including 100. When the project is complete, all reasonable demands for values of the J Bessel functions of integer order would seem to be met. The 18-decimal values of volumes 3 and 4 constitute in themselves a fundamental table of major importance. If the engineer or physicist considers the provision of 18 decimal places absurdly generous, at least three replies may be made. It is easier to discard unwanted figures than to supply any desired beyond those given in a table; it is relatively inefficient to use a complicated machine at less than full capacity; to complete the project by the proposed use of the recurrence formula needs in the fundamental tables more than twenty decimals (the machine computes twenty-three) in order to secure everywhere ten *reliable* decimals.

We must be grateful for an achievement of such magnitude and enduring permanence, although one cannot help endorsing Dr. Comrie's wish that the resources of this computing engine had been deployed in fields where it could make significant additions to our knowledge.

But these large volumes—the page size is 7½ in. by 10½ in., and the four occupy together 7½ in. of bookshelf—inevitably bring to mind other questions. It is clear that in this machine we possess the means of 'mass-producing' the values of a class, limited but still very large, of mathematical functions: Computation, in this field, is no longer a crucial problem. It is now to the inter-related question of reproduction and accessibility of the results that some thought should be devoted. The volumes of the present project, when completed, will occupy some 5 ft. of bookshelf, but will cover only the J functions of integer order. Add also the I-, Y-, and K-functions, the Bessel functions of these types of half-odd-integral order, the *ber*, *bei*, and related functions in the Bessel family; then imagine the elementary functions, and the others which appear in, say, Whittaker and Watson's "Modern Analysis" treated equally generously. The size of the resulting library of mathematical tables becomes to a librarian frightening on the scores of both space and finance, and to the user embarrassing and forbidding.

Photographic reproduction from typescript, as used in these and other tables, has disadvantages which go some way to offset its evident advantages. Compared with good examples of tables printed from type the numerals are larger, but despite this are more fatiguing to use for any length of time. Most of the examples of mathematical tables photographically reproduced from typescript which the writer has seen are bulky owing to the use of relatively thick, absorbent paper; is this inevitable? Finally, is it impossible to harness modern computing machinery to some form of mechanical compositor, so that the advantages of appearance, legibility and compactness of the printed page may be combined with that saving of the labours of the compositor and the proof-reader which the method of reproduction of these volumes enjoys?

W. G. BICKLEY

SCHOOL BROADCASTING IN BRITAIN

School Broadcasting in Britain

By Richard Palmer. Pp. 144 + 27 plates. (London: British Broadcasting Corporation, 1947.) 3*s*. 6*d*. net.

AS Sir Henry Richards points out in a foreword to this volume, the publication of this "first considerable contribution" on the subject of school broadcasting requires neither apology nor explanation. Much has happened since the Carnegie Trustees undertook that pioneer investigation into the possibilities of broadcasts to schools, the results of which were made available in 1928 in "Educational Broadcasting: a Report of a Special Investigation in Kent". That progress should have been so rapid in the past twenty years is the more surprising when "the sceptical though benevolent neutrality" which characterized the attitude of educationists in the early twenties is recalled.

The task which Mr. Palmer has set himself is that of interpreting the work of his colleagues and himself; and it is one for which he is admirably equipped. A former lecturer in education in the University of Liverpool, he joined the staff of the School Broadcasting Department of the B.B.C. in 1940 and, in addition to a particular responsibility for science broadcasts, has had for seven years wide experience in the work of the department. His own contributions—which are made in ten chapters—are enriched by Miss Mary Somerville's account of "How School Broadcasting Grew Up", by Mr. John Horton's analysis of recent experiments in music, and by Mr. Edward Wall's discussion of modern language broadcasts.

Of particular interest to educational psychologists is the concluding chapter in which Mr. Palmer analyses "Some Problems for Study". It is, for example, assumed that school broadcasting can have a considerable influence on interests and attitudes. Of the short-term influence there is abundant evidence. But what of long-term interests? Do young people develop interests and hobbies in later life as a result of their introduction to such series as "General Science", "Science and Gardening", "Nature Study" and "How Things Began"? Interesting as this and other problems discussed by Mr. Palmer undoubtedly are, the most immediate need is, as he is well aware, for extensive research into the psychology of attention.

The Design of Experiments

By Prof. Ronald A. Fisher. Fourth edition. Pp. xi + 240. (Edinburgh and London: Oliver and Boyd, 1947.) 12*s.* 6*d.* net.

ONE of the striking characteristics of modern biological statistics is its insistence on experimental design. The most powerful methods of analysis can be used, and the greatest amount of information obtained, only if the experiment is laid out with this end in view. Randomization is necessary for trustworthiness, replication for efficiency and factorial design for comprehensiveness. Without these precautions, the experiment will at best give a poorer return than it need, for the labour and materials expended on it.

The first book devoted to the exposition of these modern principles of experimentation and their translation into design was "The Design of Experiments", the fourth edition of which has just appeared. This now standard work has been changed but little since its first appearance, and the only new addition, a valuable one, is a section on the fiducial limits of a ratio. The reappearance of this book will be welcomed by all who have an interest in biological experimentation.

K. M.

Wonders of Natural History

By E. L. Grant Watson. Pp. 192. (London: Pleiades Books, Ltd., 1947.) 8*s.* 6*d.* net.

THIS entertaining and attractively illustrated volume is a reprint of two earlier works, "Enigmas of Natural History" and "More Enigmas of Natural History". To the layman who reads for pleasure, and to the biologist who may read for profit, the author has much to tell that is curious, fascinating, wonderful and puzzling. That is the way of Nature, though we sometimes forget it. But at almost any point, in making casual observations on the life-history or habits of bird or insect, we are brought sharply face to face with the unknown, with phenomena on which the professed biologist so far has little positive to say. A realization of this prevailing state of affairs, an eye for telling examples, and a power of simple, lucid statement, are among the merits of the present work. At the end of almost every paper the author comes to the same point: How was this curious development or relationship brought about in the course of evolution? Is it conceivable that the many complex adaptations, each occupying its proper place and sequence in the individual life-cycle, are merely the result of continuous small variations, or even larger ones? These are still and always will remain topics of major interest in biology. It is good that we should occasionally be reminded of them.

Australia

Its Resources and Development. Edited by Prof. G. L. Wood. Pp. xvii+334+28 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 20*s.* net.

MORE than a dozen authorities on various aspects of Australia have contributed to this survey of the economic resources and the prospects of the Commonwealth. In a short but sincere discussion on the peopling of Australia, "the general conclusion reached is that the growing period over three-quarters of Australia is not long enough for commercial agriculture". Much of it, however, is suitable for grazing of sheep or beef cattle. Several of the writers dwell on the problem of water, the risk of drought, the limitations of irrigation and the exploitation of artesian water. Water supply is, of course, linked with hydro-electric resources, which are abundant only in Tasmania and especially in New Guinea. The extent of mineral resources, fuel and possible industrial development are fully considered, and these as well as other problems are approached objectively and fully. Altogether this is one of the most valuable books on Australia that has appeared in recent years. It is illustrated with many photographs and maps.

Current Waterworks Practice

A Practical Treatise on the Provision of Water Supplies for Urban and Rural Communities. By W. H. Maxwell. Pp. viii + 254 + 20 plates. (London: B. T. Batsford, Ltd., 1946.) 21*s.* net.

THE increasing attention being given to the provision of wholesome water supplies to dwellers in country districts as well as in urban localities has prompted the author to prepare this very useful and practical treatise dealing in a generally comprehensive, and yet succinct, way with the various problems which arise in connexion with projects of water supply. It includes a discussion on a national water policy for rural and other areas, with transcripts of the provisions of the Rural Water Supplies and Sewerage Act, 1944, and the Water Act, 1945. The greater part of the work is of a practical and detailed character, commencing with a description of underground water resources and means for their conservation and protection from pollution, and then proceeding to discuss such matters as the choice of electric motors and other equipment for pumping installations; concrete and cement for constructional work, including the use of reinforced concrete; automatic pump control; methods of water purification and the sinking of wells. The volume is well illustrated by diagrams, and there are particulars and photographs of installations in Great Britain and abroad, showing current practice in reservoir construction. Among the appendixes is a useful statement of water equivalents and other data. There is a serviceable index.

B. C.

The Arboretums and Botanical Gardens of North America

By Dr. Donald Wyman. (Chronica Botanica, Vol. 10, No. 5–6.) Pp. 395–498 + plates 27–43. (Waltham, Mass.: Chronica Botanica Co.; London: H. K. Lewis and Co., Ltd., 1947.) 1.50 dollars.

OWING to the difficulty at the present time in obtaining factual information regarding staffs and equipment of scientific institutions, this account of the botanic gardens and arboretums of North America is welcome. Its survey deals with about ninety gardens of varying importance ranging from the New York Botanical Garden, the Arnold Arboretum, to smaller gardens connected with the botanical departments of universities and also those privately owned but open to the public.

In every case, the function, brief description of special features, ownership, size of collections, herbarium, budget, director, number of employees and list of publications are given.

In addition, a portfolio of prints and photographs of some of the more famous gardens, old and modern, American and foreign are given. There are also plans of some of the larger gardens. A very useful book of reference.

JUBILEE OF THE DISCOVERY OF THE ELECTRON

IN 1897, Prof. J. J. Thomson, working in the Cavendish Laboratory at Cambridge, discovered that cathode rays consist of negatively charged particles (electrons, as they afterwards came to be known) many times smaller in size than the smallest atoms known. During the fifty years that have elapsed since that discovery, it has been established that electrons form an essential part of all matter. Numerous practical applications of the use of electrons have been found, and vast new industries have been set up based on electronic devices. On the theoretical side, the discovery of the electron has opened the way to research into the structure of the atom, and, more recently, into that of the nucleus, leading finally, for better or worse, to the release of atomic energy.

To mark the jubilee of the discovery of the electron, celebrations were held recently in London by the Institute of Physics and the Physical Society in collaboration with the Institution of Electrical Engineers. On the afternoon of September 25, at the Royal Institution, Prof. J. A. Crowther gave a lecture on the history and early development of the discovery. He was followed by Prof. R. E. Peierls, who spoke on electrons in modern theoretical physics. In the evening, a public lecture was delivered to a very large non-technical audience at the Central Hall, Westminster, by Sir Clifford Paterson, director of the Research Laboratories of the General Electric Co., Ltd., on "The Electron Liberated". On the following day, the Electron Jubilee Exhibition at the Science Museum, South Kensington (see *Nature*, Oct. 4, p. 461), was formally opened. At the Institution of Electrical Engineers, a posthumous portrait of Sir J. J. Thomson, painted by Mr. Francis Hodge, was unveiled by 'J. J.'s' son, Sir George Thomson, who then addressed the assembly on the electron in research. He was followed by Dr. T. E. Allibone, who spoke on electrons in industry.

Prof. A. M. Tyndall, president of the Institute of Physics, in introducing Prof. J. A. Crowther, stated that the suggestion to celebrate the jubilee of the discovery of the electron had originated from a remark made by Dr. A. J. Maddock. The suggestion was taken up enthusiastically by the Board of the Institute of Physics, which then invited the Physical Society and the Institution of Electrical Engineers to join in the organisation of a series of meetings which would be thoroughly representative of the two sciences—physics and electrical engineering—which had been most directly affected by the discovery of the electron. Prof. Tyndall invited the meeting to send the following message of greeting to Lady Thomson, who was prevented from being at the meeting. "Representatives of science and industry, together with old friends, assembled at the Royal Institution to-day to commemorate the fiftieth anniversary of the discovery of the electron by your husband, send you warm greetings and best wishes."

Opening his lecture, Prof. Crowther said that in order to appreciate to the full the discovery of the electron and the genius of its discoverer, Sir J. J. Thomson, it was necessary to be aware of the ideas prevalent in the pre-electron era, and perhaps also the facilities available then. He therefore briefly outlined the position of physical knowledge in 1897 and the course of events which led up to Thomson's experiments. Prior to 1890, the study of electrical discharges in a vacuum tube had progressed very slowly, no doubt partly due to the extremely laborious methods of evacuation which had to be used, and also partly to the lack of serious examination of the beautiful phenomena observed. Schuster, in 1890, made the first real attack on the problem of elucidating the nature of the cathode rays, when he took the trouble to measure the magnetic deflexion of the rays in a measured magnetic field. The accepted view of British physicists at the time was that the cathode ray particles were atoms, so that the energy given to them by the electrical field would be all used up in driving the particles through the residual gas present in the discharge tube. Working on this assumption, Schuster obtained a value of 2,000 for the ratio of the charge e to the mass m of the cathode particle, a value which is consistent with the cathode particle being a nitrogen atom. The experiments performed by Hertz, Lenard and Perrin during the next few years did not help to clarify the situation, but provided rather conflicting evidence.

This was the baffling state of affairs when J. J. Thomson entered the lecture room of the Royal Institution on the evening of Friday, April 30, 1897, and delivered his now historic lecture on "Cathode Rays". Quoting from Thomson's lecture, Prof. Crowther showed how the results of Perrin's and Lenard's experiments were first carefully analysed by Thomson, leading him to the conclusion that "the size of the carriers must be small compared with the dimensions of ordinary atoms and molecules"; and then, further, how Thomson startled his audience with the bold and revolutionary conception that the atom has a structure which could be explored. By the October of 1897, Thomson was in a position to present, in the *Philosophical Magazine*, additional experimental evidence in support of his claims. This evidence included the now famous and elegant measurement of e/m for cathode particles. Finally, at the British Association meeting in 1899, Thomson announced that he had measured both e/m and e for the corpuscles emitted by a zinc plate when illuminated with ultra-violet light, thus identifying them with the cathode ray particles. From then onwards, as Prof. Crowther so tastefully expressed it, "the electron was accepted as a respectable member of society".

Prof. Peierls, who was introduced by Prof. G. I. Finch, president of the Physical Society, dealt with the effect which the electron, together with its associated fundamental particles, the positron, neutron, meson and neutrino, has had on the theoretical development of the laws governing the behaviour and structure of matter. The breakdown of classical mechanics led to the introduction of quantum theory and wave mechanics, with the consequent realization that the distinction between waves and corpuscles is not as fundamental as had been thought. In some respects the electron can behave as a wave, and in other respects as a corpuscle, particularly when it is moving slowly compared with the speed of light. The last remaining feature of the electron, its spin, was deduced by Uhlenbeck and Goudsmit from their work on atomic spectra. The consequences of these new laws have helped in the understanding of the structure of solids, the properties of metals and in particular the conduction of electricity through metals, leaving perhaps only one outstanding unsolved problem, superconductivity.

J. J. Thomson himself had noted that the mass of the electron increased with the speed, the first and the simplest proof of relativity. The incorporation of the relativity idea into the equations for the electron was done brilliantly by Dirac, and this not only reproduced all the known cases for slow-moving electrons, together with a gratuitous 'spin', but also introduced negative energy states predicting the existence of the positron, discovered somewhat later. Prof. Peierls, in conclusion, referred to the present-day difficulties, stating that the electron will not be completely understood until the reason for its comparatively weak charge is known.

Sir George Thomson was welcomed by Dr. V. Z. de Ferranti, president of the Institution of Electrical Engineers, who reminded the audience that Sir George was best known for his discovery of electron diffraction, in which the electron behaves as a wave, and which has had important industrial developments.

Two applications of electrons, their use for the study of the very small, and for the production of very high voltages, were considered by Sir George, in his lecture on the electron in research. Since electrons possess wave properties analogous to light, any optical instrument has an electron analogue. The two most important are the electron microscope, which follows its optical model very closely whether employing electrostatic or magnetic lenses, and the electron diffraction camera, where the electrons are diffracted by the regular arrangement of the atoms in a crystal, similar to light by a ruled grating. Dr. Raether's work on the polishing of rock salt, in which the surface was examined both by electron diffraction and by the electron microscope, was described by Sir George, and slides shown of the results obtained to illustrate the use of electrons for the examination of the very small, and the complementary nature of the two methods.

Nuclear physics requires energies of not less than 100 MeV., so that methods of producing high voltages are becoming increasingly important. Limiting attention to electrons, the Van de Graaff electrostatic generator, the betatron, the synchrotron with its variant the microtron, and the linear accelerator are the more important machines for generating high-speed particles, and these were briefly explained by Sir George, who gave several interesting details of some of the generators now in use or under construction. The high-energy electrons, it was pointed out, are most often used to produce X-rays, of great value industrially for the examination of castings, etc., and medically for direct use in therapy.

The applications of electrons in industry was the subject of the lecture by Dr. Allibone, who followed Sir George, and who was introduced by Dr. P. Good, president-elect of the Institution of Electrical Engineers. Dr. Allibone confined his remarks to the free electrons, that is, electrons separated from the atoms to which they are usually attached. He pointed out that Sir J. J. Thomson in 1895 and 1897 dealt with free electrons, and that J. J. Thomson's modified Crookes tube was the forerunner of the present-day cathode ray tube, which industry has developed and is now producing at the rate of 100,000 a year, rising very shortly to a million a year. Modern developments of cathode ray tubes have concentrated on improving the electron optics, and on increasing the energy, of the electron beam, in order to meet the desire of the engineer to examine electrical transients of very short duration. Dr. Allibone referred to several of the improvements that have been made, and to other applications of the cathode ray tube, in radar and projection television. He next reviewed thermionic emission, and the many different types of thermionic tubes, giving instances of their uses, particularly in induction and dielectric heating and in communication engineering. But J. J. Thomson's observations were not confined to electrons liberated by thermionic emission. In 1899, as Prof. Crowther mentioned earlier, he had measured *e/m* for electrons emitted by photo-electric emission from a zinc plate illuminated by ultra-violet light. Modern technique has now extended the photo-electric effect into the infra-red region, and the photo-electric cell finds its application in thousands of industrial processes. Dr. Allibone singled out for special mention the electron multiplier, the television camera, and the war-time development of infra-red sensitive cells. Finally, he dealt with field emission, that is, electrons made free from a surface by the action of intense external electric fields, a phenomenon which J. J. Thomson never examined himself, but which is important in several branches of vacuum engineering. Dr. Allibone concluded his interesting talk, which he had illustrated by many slides, by showing a portion of the film of Sir J. J. Thomson, which the Institution of Electrical Engineering made some ten years ago, and which represents 'J. J.' in the affectionate manner which endeared him to all.

The public lecture delivered by Sir Clifford Paterson, who has the distinction of being a past president of both the Institute of Physics and of the Institution of Electrical Engineers, was naturally less academic than the four lectures delivered before the learned societies. The audience was entertained by an instructive series of experiments and demonstrations, in which they saw how the scientific worker and the engineer, armed with the knowledge provided by J. J. Thomson that electricity consists of an immense number of minute particles, the electrons, have devised means of liberating these electrons from solids, and then developed and used every kind of free electron agency and device. Forty years of development has resulted in a vast industry, 'electronic engineering', engaged in the production of these numerous electric devices, which have changed and are indeed revolutionizing the life of the community. Two electron liberator devices in particular, the radio valve, utilizing thermionic emission from a filament and controlling the electron stream by means of the other electrodes, and the photo-electric cell, which has a specially sensitized cold surface from which electrons are liberated by the action of light, were described by Sir Clifford. To illustrate the power of the tool that the physicist has put into the hands of the electrical engineer, a most convincing demonstration was given of the conversion of sound from a gramophone record into electrical impulses, then into light waves, back into electrical and mechanical waves to sound once more, with several intermediate stages of amplification. In the latter half of the lecture, electrons in relation to lighting was discussed. The progress made in gaseous discharge tubes for illumination purposes was elegantly demonstrated, as well as the improvement in the ordinary electric lamp. It is interesting to note in this connexion that if fluorescent lamps became universal, a saving of nearly two million tons of coal a year and two large generating stations the size of that at Battersea could be effected.

Although the celebrations were to mark the jubilee of the electron, everyone who listened to the lectures or sees the Exhibition is bound to be impressed by the still great youthfulness and vigour of the electron, for the potentialities of the new science of electronics are attracting to their study and exploitation such an amount of skill and enterprise that what has been accomplished can be regarded only as a beginning of the achievements of the liberated electron.

S. WEINTROUB

INTERNATIONAL STANDARDS AND UNITS OF RADIOACTIVITY

THE first international radium standard was prepared by Mme. Curie in 1911; it consisted of 21·99 mgm. of purest radium chloride. By comparing its radiation with those from other radium sources, the latter could be measured and their radium contents expressed in grams. For the measurement of radon, grams (or cubic centimetres) of this gas are impracticable as units, and it was therefore decided to use as unit of radon the quantity which is in radioactive equilibrium with 1 gm. of radium; it was called a 'curie'. Standards for radon measurements were prepared in the form of solutions of radium salts.

Since the comparison of radioactive sources with the standards always involved measurements of ionization currents, or of the number of disintegrations per unit of time, and as especially the latter figure could be determined with much higher accuracy than the weight of the radium preparation, it became customary to base the curie directly on the number of alpha-particles emitted. According to the best measurements, 1 gm. of radium and, naturally, also the radon in equilibrium with this quantity, emits per second $3 \cdot 7 \times 10^{10}$ alpha-particles; in recent practice, unknown radioactive sources were measured in curies by comparing their particle emission with this figure. Thus the curie became the unit in which the strength not only of members of the radium family, but also of any radioactive source, could be expressed.

This important change in the principle of radioactive measurements and in the definition of the curie was never officially sanctioned, because the International Radium Standard Commission which was responsible for the early conventions on radioactive standards and units has for a long time not been able to function satisfactorily. To remedy this situation, the proposal was made by E. U. Condon and L. F. Curtiss (*Rev. Sci. Instr.*, **17**, 249; 1946) to introduce as a new unit the activity of 10^6 disintegrations per second, and to call it a 'rutherford'.

It is obvious that an international agreement is imperative, whether the 'curie' in its original or in its modified form, or the new unit, the 'rutherford', should be used. The International Congress of Chemistry recently held in London offered to a number of workers in radioactivity from various countries an opportunity to discuss this question among themselves. Under the chairmanship of Prof. F. Joliot-Curie (Paris), on July 19, a meeting was held by Ellen Gleditsch (Oslo), G. de Hevesy (Stockholm), Irene Joliot-Curie (Paris), C. Jacobsen (Copenhagen), W. A. Noyes, jun. (Rochester), F. A. Paneth (Durham) and G. J. Sizoo (Amsterdam); and after an exchange of views they decided to make the following recommendation.

A new committee on radioactive standards and units, comprising mainly representatives of the International Union of Chemistry and of the International Union of Physics, should be formed; but all the surviving members of the old International Radium Standard Commission should be invited to join them. As representatives of the International Union of Chemistry the names of E. Gleditsch, G. de Hevesy, Warren C. Johnson, F. Joliot-Curie, F. A. Paneth and G. T. Seaborg were suggested; as representatives of the International Union of Physics those of L. F. Curtiss, Sir Charles Darwin, R. B. Evans, C. Jacobsen, Irene Joliot-Curie and G. J. Sizoo.

Those present at the meeting were unanimously in favour of preserving the name of 'curie' as the unit of radioactivity, but to define it now officially as the quantity of a radio-element which undergoes $3 \cdot 700 \times 10^{10}$ radioactive transformations per second. The final decision, however, will have to await the recommendations of an international committee on radioactive standards, the formation of which was advocated.

QUANTITATIVE ASPECTS OF FREE RADICAL CHEMISTRY

By Prof. H. W. MELVILLE, F.R.S.

University of Aberdeen

THE Faraday Society held a two-day meeting in Oxford during September 23–25 to discuss "The Labile Molecule", or the quantitative aspects of free radical chemistry. The nature of the discussion seemed commonplace enough, and the tremendous activity in this field of chemistry is almost taken for granted. If we neglect the war years—and that is not quite justified—the subject seems to have grown up in about five scientific years, from a rather tentative qualitative notion to a subject of considerable precision requiring for its practice a wide variety of advanced techniques.

The attempts to unravel the mechanism of chemical reactions, the mechanism of which does not involve ions, is really the story of the development of the kinetics of homogeneous reactions. Many reactions, and especially those involving halogens, are known to involve free atoms as essential intermediates. These are, in fact, the activated 'molecules' in the old Arrhenius sense. But the idea that free organic radicals could function in a similar way, though possible in principle, came at a much later stage. The preparation of simple aliphatic radicals by the thermal decomposition of metallic alkyls, and later of a large number of simple organic molecules, provided the idea that radicals might play a part in the thermal decomposition of molecules the spontaneous decomposition of which was regarded as occurring simply by fission into simpler molecules but not radicals. Similarly, a great deal of work on the photochemical decomposition of compounds like the simpler aliphatic ketones could only be satisfactorily explained if it were assumed that the first step in the reaction consisted in the fission of a carbon – carbon bond with the production of two free radicals. Such experiments, however, gave little quantitative information about the reactivity of the radicals produced, for the simple reason that the radicals mostly recombined, and therefore the velocity of decomposition was fixed by the initial rate of decomposition of the ketone. The kind of information that is now required about the behaviour of radicals is much more comprehensive, for it is a relatively easy matter to find whether radicals are involved in a reaction; and often the chemistry of the reaction is simple enough for the precise nature of the radical to be specified. There are at least four distinct types of radical processes about which quantitative information is required. (*a*) The rate of radical production by thermal activation, by thermal decomposition of relatively unstable substances such as peroxides and azo compounds and by photodecomposition of molecules. (*b*) The interaction of radicals with saturated molecules, in which usually an atom is removed, generating thereby another kind of radical the reactivity of which may differ markedly from that of the original radical. (*c*) The interaction of radicals with unsaturated molecules in which the radical adds on to the double bond, producing in this way a larger radical again of a different activity from that of the original. (*d*) The interaction of radicals with each other or with other radicals present. Such a process is the only way in which the radical is finally removed from the system.

This general list of collision types comprises the essential steps in all radical reactions, no matter whether the overall effect is the oxidation of hydrocarbons, the polymerization of vinyl compounds, the addition of carbon tetrachloride to olefins, or the addition of hydrogen bromide to double bonds between carbon atoms. It is with this more general aspect of free radical chemistry in mind that the discussion took place, and in particular the emphasis was laid on the absolute magnitude of the velocity coefficients of the above-mentioned reactions. This quantitative approach raises at once two matters. First, it is necessary to devise methods of measuring velocity coefficients, which implies a kinetic analysis of reaction mechanism with a degree of unambiguity and precision which is not easily attained. Secondly, the provision of data of this kind gives the theoretical chemist great opportunity to attempt further to correlate reactivity and chemical structure for free radical reactions.

For convenience, the discussion was broken up into the following constituent parts, each of which has contributed much to our understanding of free radical reactions: (*a*) a theoretical part dealing with the calculation of the structure, energies and reactivity of free radicals; (*b*) radical reactions in the gas and liquid phases; (*c*) oxidation reactions; (*d*) polymerization reactions. Although the existence and behaviour of free radicals was first studied in the gas phase, the predominant interest appears to have shifted to the liquid phase, where the variety of effects is naturally much greater. Fortunately, it appears that the complications that might arise in working in a condensed system are not quite so serious as were first imagined.

In spite of a great deal of experimental work, the reactions of gaseous simple hydrocarbons with free radicals derived from them are still somewhat obscure, and much effort is still required before even qualitative data can be reliably obtained. For example, there is only now fairly general agreement about the energy of activation for the $CH_3 + H_2 \rightarrow CH_4 + H$ reaction, namely, between 7 and 9 k.cal., the temperature-independent factor not being particularly small. Besides monoradicals, great interest is attached to the behaviour of diradicals, both in hydrocarbon chemistry and in polymerization reactions. The methylene radical can be produced either by the photodecomposition of keten or by the action of sodium vapour on methylene bromide. In the former case, the CH_2 molecule attacks metallic mirrors with vigour, and it must be presumed that it acts as a diradical and not as a stable molecule CH_2. Yet when produced under the conditions obtaining in a sodium 'flame', the radical does not apparently dimerize to ethylene but undergoes a variety of other reactions. Another very interesting way in which aliphatic free radicals can be formed at low temperatures is by the thermal decomposition of silver methyl and silver ethyl, in the range − 60° to − 20° C. With ethyl radicals both combination and disproportionation occur even at these low temperatures.

Oxidation of hydrocarbons to hydroperoxides is now well recognized to occur by a mechanism involving *R*- and *R*OO-radicals. Even the OH radicals produced by the interaction of Fe^{++} and hydrogen peroxide will provide the necessary stimulus for initiating oxidations of this type. Further, it is now becoming clear that the action of retarders in such oxidations involves the attack of the retarder by the *R*OO— radical. By the use of hydroquinones and similar compounds as retarders, it has been shown there is a quantitative relationship between the logarithm of the velocity coefficient and the oxidation-reduction potential of the hydroquinone–quinone system. In the hydrogen–oxygen reaction, the radical corresponding to RO_2 is HO_2, the existence of which seems essential to the formulation of a satisfactory scheme of reaction. Similarly, a theoretical investigation confirms the stability of this radical, though no direct evidence is as yet forthcoming. Spectroscopic examination of flames provides conclusive proof of the existence of radicals, BrO and CBr being recent additions to the list. The difficulty, as always, is to determine whether such radicals exist under conditions where flame propagation is absent. The CHO radical can be identified in flame, and now its presence has been detected in photodecomposing formaldehyde by exciting it to fluorescence in the ultra-violet region of the spectrum.

The advances that have been made in studying the polymerization of vinyl compounds have provided more information about free radical processes than any other type of reaction. It is now so firmly established that these chain processes occur through the intermediary of free radicals that it almost becomes possible to use polymerization reactions as a suitable tool to study free radical reactions. Here, fortunately, there is no doubt about the general nature of the free radical, for it is either derived by the opening out of the double bond to form a diradical or by the attachment of a separately produced monoradical *R*— to the double bond: $R + CH_2 = CHX \rightarrow R.CH_2.CHX$. One very common method of producing *R*— radicals is from the decomposition of peroxides of the type $(R.COO)_2$, the radical *R*COO being first formed and carbon dioxide eliminated before *R*COO attacks the double bond. Other radical-producing substances are badly needed, and now it is reported that N-nitrosoacylarylamines will function in a similar fashion. For example, N-nitroso acetanilide will break up with the formation of a phenyl and acetate radical and the elimination of a molecule of nitrogen. While it is of great importance to measure the rate of production of radicals in polymerization, the most important step is the interaction of the radical derived from the monomer, namely, $R - + CH_2 - CHX$ with another monomer molecule to form a still larger radical—the all-important growth-step.

In order to compute the velocity coefficient from the rate at which monomer disappears, it is necessary to know the stationary concentration of the free radicals. Fortunately, this can now be done, since we know the rate of production of radicals and the time required for the concentration to fall to half its value when the source of activation is removed, either by the use of intermittent radiation when the life is short, or by direct observation of the decay of the rate of polymerization when the life is long. Unfortunately, the results are confined to vinyl acetate, methyl methacrylate and styrene at present; hence it is a little too early to see how structure affects reactivity. In the meantime, information has been obtained in a somewhat less direct manner. By studying the copolymerization of two monomers A and B, and analysing the composition of the copolymer formed during the reaction, starting with known concentrations of A and of B, it is possible to calculate the value of two factors, namely, the ratio of the rates of reaction of A and of B with a B-radical, and the ratio of the rates of reaction of A and of B with an A-radical. Therefore, A may be kept fixed and the nature of B altered by changing the nature of the substituent X of the vinyl compound $CH_2 = CHX$. In this way it is possible to get a whole series of monomer reactivity ratios which give relative values for the growth steps in polymerization.

This material has provided the data for tentative theories of reactivity. As a first approximation, it may be supposed that there can be ascribed a potential reactivity of the free radical and also of the monomer which is going to be attacked. It has been suggested that the magnitude of the electric change on the group X will play a predominant part in effecting radical – molecule interaction, and there is some evidence to support almost a purely electrostatic approach to the theory. On the other hand, there is another school of thought which argues in rather a different way; basing relative reactivity on the relative values of the resonance energy of the radical–monomer system before, during and after interaction. Qualitatively, it is possible to go some way with such theories, and most important of all, to incorporate radical – monomer reactivity in the more general theory of the effect of the character of substituents in the reactivity of neighbouring groups. There is, however, a long way to go before any attempt is made to compute the absolute value of velocity coefficients. Indeed, it is only fair to say that in nearly all cases the temperature-independent and temperature-dependent factors have not yet been separately determined, and the theory is wholly based on the values of velocity coefficients determined at one temperature.

When polymerization is carried out in solution, it often happens that the polymer radicals attack the solvent molecule, removing an atom, regenerating another radical which reacts with further molecules of monomer. Thus the kinetic chain is continued, but the continuity of the polymer chain is broken in this so-called transfer reaction. By observing the influence of solvent on the degree of polymerization of the polymer, it is possible to compare the relative activities of the radical attacking the monomer on one hand and the solvent on the other. Absolute values of the radical – solvent interaction can then at once be obtained if the growth coefficient is known. Polymer reactions thereby provide a very convenient and sensitive means of studying a great variety of reactions. For example, when the solvent is hydrocarbon the dominant factor that seems to govern the reactivity is the bond-strength of the weakest C—H bond. Further, if the hydrocarbon radical so produced is stabilized by possessing a large resonance energy, it may not react with the monomer, and so the kinetic chain comes to a stop. The solvent then acts as a retarder for polymerization and the molecular weight of the polymer is cut down. There is therefore little formal difference between transfer and retardation.

Degradation of vinyl polymers also presents interesting information on radical reactivity. In some cases it would appear that the mechanism of degradation is really like polymerization in reverse. If it should happen that thermal fission of a polymer occurs into two free radicals—a relatively difficult process because C—C bonds have to be broken—these radicals are rather unstable in the sense that not much energy, for example, 16 k.cal., is required to remove monomer units. Such radicals are therefore very easily removed from the system. Like the building up of polymers by chain processes, this degradation can likewise be materially diminished by adding substances that will stabilize the radicals and prevent further degradation.

PLANT TUMOURS AND ANIMAL CANCER

By R. S. de ROPP
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THE discovery by Smith and Townsend[1] that crown-gall disease of plants was caused by a bacterium (*Phytomonas tumefaciens*) aroused considerable interest among students of cancer. The view that animal cancer was of bacterial origin was vigorously put forward by Smith, who published several papers emphasizing the resemblance of plant galls produced by *Ph. tumefaciens* and to cancerous neoplasms. He distinguished several different types of plant tumours which he compared to sarcomas, carcinomas and teratomas. Secondary tumours which sometimes formed on infected plants at points remote from the original tumours were compared by Smith to the metastases observed in animal cancer. Smith was convinced that the galls produced by *Ph. tumefaciens* always contained the bacteria within their cells. As investigators of animal cancer failed to isolate any bacterium which could be definitely associated with the formation of cancer, interest in Smith's views tended to decrease.

In 1918 a paper was published by C. O. Jensen[2] which gave the first indications that tumours initiated by *Ph. tumefaciens* might continue to grow as tumours in the absence of the bacteria. Jensen worked with mangolds and sugar beets and succeeded in grafting tumour tissue from these plants on to normal roots. Many of these grafts took, and the tumour tissue continued to grow as a tumour. From all such transplanted tumours Jensen found that the original crown-gall bacteria had disappeared.

The importance of these findings was overlooked until Braun and White[3] began their studies on the secondary tumours which develop on certain plants after inoculation with *Ph. tumefaciens*. These secondary tumours were first described by Smith, who considered them to result from strands of tumour tissue which, carrying the bacteria within their cells, grew through the stems of infected plants and produced secondary or metastatic tumours. It was shown by Braun and White that such secondary tumours on sunflower are usually free from bacteria. By the application of tissue culture methods to this material, these workers were able to demonstrate that tissues removed from secondary tumours on *Helianthus annuus* will grow readily on a simple medium containing mineral nutrients, 2 per cent glucose, thiamine and glycine. White and Braun[4] also showed that normal sunflower tissue and tissue removed from tumours induced with indole-oxaloacetic acid grew much more slowly in culture and tended to differentiate roots and to form chlorophyll, which did not occur in the tumour tissue. The tumour tissue continued to proliferate abnormally when grafted *in vivo* on to stems of *Helianthus annuus* or *Helianthus tuberosus*. Bacteria-free tumour tissue capable of unlimited growth *in vitro* was also isolated from *Vinca rosea* (periwinkle) by White[5] and from primary, as opposed to secondary, tumours on sunflower by de Ropp[6].

Early in the study of crown-gall it was realized that galls would form only when bacteria encountered wounded tissue. Hildebrandt[7] showed that a single organism was sufficient to produce a gall when introduced into a needle puncture wound; but crown-gall organisms introduced directly into living cells of tomato stems "failed to induce gall formation and ordinarily failed to survive inside the cells, indicating that the living cell interior is an unfavorable medium for these bacteria". Afterwards it was shown by Braun[8] that wounded plant tissue may be rendered tumorous by the crown-gall organism in as little as 36–48 hours. He obtained this information by treating wounded stems of *Vinca rosea* with crown-gall bacteria and afterwards freeing them from the bacteria by heat. Tumour tissue developed at the site of these wounds even though the bacteria causing tumefaction had been eliminated. Following earlier work of Riker[9], Braun[10] also showed that tumour formation in wounded periwinkle tissue was inhibited at 32° C. even though virulent crown-gall organisms were present in the wounds. Some further light was thrown on the mechanism of tumour induction by work of Braun and Laskaris[11], who showed that tomato plants inoculated with a strain of *Ph. tumefaciens* which had lost its capacity to induce tumours would respond with tumour formation if treated with indole acetic acid. They concluded that a tumefacient factor and a growth hormone were both involved in tumour formation.

The sensitivity to hormones of bacteria-free crown-gall tumour tissue as compared with normal tissue was studied by de Ropp[12], who showed that, although normal tissue would respond with root formation to one part per 100,000,000 of indole acetic acid, tumour tissue was not affected by this substance. He attributed this lack of response to an excess of growth hormone present in the tumour tissue. The presence of an excess of growth hormone in plant tumour tissue was also indicated by studies of Brown[13], Riker[14], and others, who showed that plants infected with crown-gall frequently produced adventitious roots from normal plant tissues in the region of the gall. Attempts by Riker[14] to demonstrate differences in auxin concentration between normal and tumour tissue by means of the *Avena* coleoptile test were not successful.

Experiments on the interaction of normal and tumour tissue were performed by de Ropp[15], using the method of *in vitro* grafts. It was shown that 'induced tumours' frequently developed in these grafts which appeared to arise not from the tumour tissue but from the normal stem tissue to which it had been grafted. The induced tumours differed from the inducing tumour tissue in morphological characteristics but proved capable of inducing tumours when grafted to normal tissue. To account for the formation of these induced tumours, a tumefacient agent was postulated having the property of a virus or a self-perpetuating cytoplasmic entity such as has been suggested by Darlington and Haddow. If a virus is responsible for the formation of induced tumours, it is probably of the type transmissible only by grafting, as extracts of tumour tissue are without effect on normal tissue (White and Braun[4]; de Ropp[16]). The existence of such a bacteria-borne tumefacient factor has still not been conclusively demonstrated.

A comparative cytological study of crown-gall tissue and various forms of cancer tissue was made by Levine[17], who observed giant cells in the gall tissue, the nuclei of which were sometimes in the tetraploid or octoploid condition.

Two other forms of plant tumour are of interest to students of cancer, namely, the virus wound tumour of Black[18], and the *Nicotiana* hybrid tumour of Kostoff[19]. Susceptible plants can be affected with the wound tumour virus either through the agency of agallian leaf hoppers or by being grafted to infected plants. Infection is systemic and symptoms include enlargement of the veins as well as the formation of tumours on roots and stems in many species of infected plants. Most of these tumours appear to arise at points where root or stem has been wounded. Black[20] showed that the tumour tissue from sorrel could be cultured for as long as twenty months on an artificial medium without the production of roots, stems or leaves. On being grafted back to healthy plants, tissues from these cultures induced a systemic infection in the stocks, showing that the virus was still present. Such a tumour-producing virus has obvious resemblances to entities such as the Rous sarcoma virus or the Bittner milk factor.

The tumours which arise on hybrids of *Nicotiana Langsdorfii* and *N. glauca* were described by Kostoff and later studied by Whitaker[21]. Such tumours develop only in hybrids in which *N. Langsdorfii* is used as the pollen parent. The tumour tissue was cultured *in vitro* by White[22], who showed that it would continue to grow as a tumour when grafted back on to normal plants. He showed also that this tumour tissue was capable of differentiating organs *in vitro*, in which respect it differs from crown-gall tissue and virus wound-tumour tissue.

Clearly, the three forms of plant tumours here described have certain properties in common with those neoplasms in animals which are collectively referred to as cancers. The resemblance is closest in bacteria-free crown-gall tissue and Black's virus-tumour tissue. *Nicotiana* hybrid tissue seems more nearly normal in its behaviour, having the capacity to differentiate organs which the other tumour tissues appear to have lost. It is interesting to note that gall formation by *Ph. tumefaciens* and Black's virus seem always to be associated with wounding, suggesting that a hormone mechanism is involved. In *Nicotiana* hybrid tumours the abnormal growth results, according to Whitaker, from a cytoplasmic disturbance occasioned by the introduction of the chromosome complement of *N. Langsdorfii* into the cytoplasm of *N. glauca*. Thus, the work on plant tumours has brought to light three factors—virus, hormone and genetic—which may act singly or in combination to produce pathological growth. This trio of etiological agents is already familiar to students of animal cancer.

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NEWS and VIEWS

Royal Society: Anniversary Meeting

In the course of his anniversary address, delivered on December 1, to the Royal Society, the president, Sir Robert Robinson, referred to the fact that, as "a privileged body", the Society, represented by the president, vice-presidents, and officers, attended at Buckingham Palace to present an address on the occasion of the marriage of Princess Elizabeth to Lieut. Philip Mountbatten; the King replied, referring to the intimate association for so many years between the Royal Society and the Crown.

Sir Robert also read the following telegram, sent by the Council of the Royal Society to Sir Charles Sherrington on the occasion of his ninetieth birthday on November 27:

"The Royal Society sends you its greetings and good wishes for your birthday. We think of our former President with especial pride and affection—we are proud of your scientific achievement, of the fresh light you have thrown on the hidden dealings of the nervous system, of the many pupils you have inspired and of the originality and distinction which has informed your scientific writing. We are proud of the philosopher who has first learnt the wisdom of the body and of the poet who can touch the springs of the mind. But on this birthday we think not so much of the great scientist as of the well-loved friend of many years who has won universal esteem by his kindness and generosity and by the courage and purpose of his life. You have set us an example for which we thank you, and we wish you all the happiness which you have so well deserved."

Referring to scientific events of the past year, Sir Robert said the most interesting development in the relations between science and administration during the past year was the formation of the Defence Research Policy Committee and the Advisory Council on Scientific Policy. The two bodies are intended to provide for scientific consultation at the highest level in government. It has been feared, however, that this may lead to infringement of the freedom of research by some form of planning or control. Sir Robert thinks that, apart from what he termed "the subtle effects of selective encouragement", there is little danger on that score; for he feels sure the present Government realizes the importance of untrammelled scientific research and its free development. It has also been objected that the Royal Society is no longer, as in the past, to have direct contact and collaboration with ministers and Government Departments. Sir Robert said in comment on this point that the Royal Society has surrendered none of its power to take the initiative or its traditional privilege of access to authority. The new developments have been the inevitable outcome of the enormous extension of Government interest in scientific work of all kinds, making the creation of a permanent liaison organisation with full-time staff a necessity. The Royal Society took the initiative during the past year in an investigation of the delays occurring in the publication of scientific papers. In the case of the Society's own publications, the time between the receipt of a paper and its publication is now about twice that occurring in 1938. Many scientific societies are probably in worse case. A major cause of this delay appears to be a shortage of skilled compositors; the Minister of Labour and National Service has intervened in the matter and improvement is hoped for. Sir Robert also stated that discussions for improved accommodation for scientific societies had continued. No agreed scheme of co-operation was available, so a committee has been formed to explore the problem in detail and to prepare alternative plans. Sir Robert's scientific theme was "An Essay in Correlation arising from Alkaloid Chemistry"; it is hoped to print this shortly, and also the remarks made during the presentation of the medals for 1947.

Dr. D. C. Martin, formerly of the Chemical Society, took up the appointment of assistant secretary of the Royal Society on January 1, 1947.

Officers for 1948

At the anniversary meeting of the Royal Society held on December 1, the following were elected as officers and council for the ensuing year: *President*, Sir Robert Robinson; *Treasurer*, Sir Thomas Merton; *Secretaries*, Sir Alfred Egerton and Sir Edward Salisbury; *Foreign Secretary*, Prof. E. D. Adrian; *Other Members of Council*, Prof. J. D. Bernal, Prof. W. Brown, Prof. S. Chapman, Prof. A. C. Chibnall, Prof. C. A. Lovatt Evans, Prof. W. E. Garner, Prof. A. C. Hardy, Sir Norman Haworth, Prof. H. D. Kay, Dr. C. H. Kellaway, Prof. M. L. E. Oliphant, Dr. C. F. A. Pantin, Prof. H. H. Read, Dr. A. E. Trueman, Mr. B. N. Wallis and Dr. J. H. C. Whitehead.

Robert Liston (1794–1847)

ROBERT LISTON, who died in his prime of an aortic aneurysm on December 7, 1847, is chiefly remembered as the first surgeon in Europe to operate under ether anæsthesia. He remarked at the time: "This Yankee dodge beats mesmerism hollow". He was not a good writer or speaker, and he contributed little to the science of surgery, but he was unsurpassed as a lightning and dexterous operator, whose methods of crushing stone and amputating thighs were the envy and despair of other surgeons. Educated at the University of Edinburgh, he became assistant to John Barclay, the anatomist. In London he worked under the two Blizards and attended Abernethy's lectures. Quarrelling with the authorities, he was expelled from the Edinburgh Royal Infirmary, but was reinstated as surgeon five years later. In 1834 he was elected surgeon to the newly founded hospital attached to the University of London. Six feet two inches in height, Liston was a man of fabulous strength, whose brusque voice was known to strike terror in the hearts of students and patients. His publications include "The Elements of Surgery", 1831–32, and "Practical Surgery". 1837. Liston is eponymously commemorated through 'Liston's long splint', which remained popular well into this century, and through 'Liston's bone-forceps', which are still in common use.

Science in Post-Primary Education

IT is encouraging to see that the Association of Women Science Teachers is fulfilling its aim of producing a series of reports on science in post-primary education. Whereas Parts 1 and 2 of this series dealt more with the principles of this education, their application to grammar school pupils of 11–18 years, and reference to subsequent training in universities and colleges, the third part of the report just published has been written in response to requests for advice on science syllabuses to those planning courses in the secondary modern schools (Science in Post-Primary Education. Third Part of the Report of a Sub-Committee of the Association of Women Science Teachers. Work in Secondary Modern Schools. John Murray, London). Recognizing that a suitably planned science course should be part of every child's work at the secondary stage, the Association of Women Science Teachers now presents specimen syllabuses for the age group 11–13 years for use in schools working under different conditions. The syllabuses are drawn up in various ways with the intention of avoiding uniformity and of offering suggestions for different methods of approach; the basic content of each has been tested by teachers in secondary modern schools. They are suitable for: a town school with laboratory and children of average ability; a similar school with children of below-average ability; a rural school with no laboratory and children of average ability; a similar school with children of below-average ability. A perusal of these syllabuses will show that the compilers recognize that the interests of the children should form the starting point for the study of scientific problems and that the study of plenty of examples and applications should come before principles are given, many difficulties in the past having arisen by the imposition of deductive thinking on those for whom it is unsuitable. It is hoped, therefore, that those teachers introducing the study of science as elementary general science into the new secondary schools will find these syllabuses useful. The compilation of syllabuses for the age group 13–15 years is contemplated, should there be a demand for them.

Physical Society of Württemberg and Baden

THE Physical Society of Württemberg and Baden recently held its first post-war meeting in Stuttgart; the meeting was convened by Prof. Erich Regener, known for his pioneer work on cosmic rays. The meeting, which lasted two days and was attended by some two hundred members, approved a significant alteration in the Society's statutes. Instead of stressing as before the purely scientific purposes of the Society, paragraph 2 now runs as follows: "The fact that the knowledge gained in physics increasingly influences the mental attitude of mankind and penetrates into all domains of human activity, imposes upon the Physical Society the obligation of keeping alive in scientific workers a sense of sharing the responsibility in the shaping of human life. The Society shall stand for the freedom, the truth and the dignity of science." In a report explaining this change, Prof. Regener points out how the trend towards de-personalization of the whole world-picture even manifested itself in the description of results (compare the frequent use of such phrases as "it has been observed", "computation shows" . . .), and how physicists often disregarded all practical applications of their science, except as a means to make better experiments. After the experience of recent years (atom bomb, etc.), the physicist can no longer be 'disinterested' in the consequences of his work without injuring both his science and himself. "Physics—and the attitude of physicists—stands to-day at the focus of public interest. The only possible attitude for us is to declare as valuable nothing but what serves the welfare of mankind, and to discard anything opposed to it."

Over-population as a World Problem

SIR JOHN MEGAW's experiences in India have impressed on his mind the need for a sustained effort to replace the natural checks on population, such as disease, famine and war, by arrangements that will involve less suffering and less inefficiency of the survivors (Occasional Papers, No. 1. British Social Hygiene Council, London. 6*d*.). He is deeply appreciative of Malthus, whom he defends against some current misjudgments. He shows that the efforts to raise standards of living above misery in Porto Rico, and in India, have largely failed because the birth-rate, or rather the survival-rate of infants, in several cases has gone up. In Porto Rico production of sugar in 1928 was nine times that of 1899, and in the same period literacy went up from 15 to 60 per cent of the population. Yet, under-feeding and general misery remain characteristic, with a birth-rate still of 40 per thousand but a death-rate reduced from 27·1 to about 20·6. The population in 1940 was nearly 1,900,000 and is now more than 2,000,000 on 3,423 square miles. The future of such a community is full of problems unless the birth-rate declines. India's increase of nearly 5,000,000 a year is even more formidable, because the problem is on such a large scale. The bibliography at the end of the pamphlet is not a very good one. Prof. A. V. Hill contributes a useful preface to the pamphlet and hopes that education carried far beyond mere literacy may help.

Indian Association for the Cultivation of Science

The annual report of the Indian Association for the Cultivation of Science, Calcutta, for the year 1946 includes the report of the managing committee, to which are appended the accounts, lists of papers published in 1946, of books added to the library and periodicals received through exchange, and of office bearers and members of the Committee of Management and the report of the Mahendra Lal Sircar professor on the scientific work of the Association. M. N. Datta's further study of the sharp type of extra spots in the extra reflexions of X-rays from phloroglucinol dihydrate has given strong support to the theory of the origin of these two types of extra reflexions advanced in earlier reports, and studies of the effect of high temperature on the phenomenon yield further support to the view that the extra spots do not originate from thermal oscillations or crystal defects. R. K. Sen continued his studies on the extra reflexions due to planar derangement waves in benzil and has also studied the diffuse extra spots of thermal origin with pyrene. B. S. Basak has extended intensity measurements of the reflexions from benzil to a large number of planes, including even weak planes, to improve upon the Fourier projections of this crystal. With A. K. Raichowdhury, he has also set up a suitable X-ray tube for studies on the structure and phase diagrams of alloys of beryllium and aluminium, and beryllium and copper. B. K. Banerjee has continued X-ray investigations of glass systems, including dispersions of platinum in Lindemann glass and of cobalt, nickel, copper and chromium oxides in borax glass. X-ray studies of Indian coal have been made by N. N. Gupta, and A. K. Datta's studies of the electrical conductivities of well-developed single crystals of molybdenite indicate that the conductivity at higher temperatures is predominantly electronic. The absorption and fluorescent spectra of anthracene, perylene, phenanthrene, naphthacene and pyrene in different solvents have been investigated by S. G. Ganguly in an attempt to determine the cause of the variations in spectral distribution of the fluorescent light with the solvent used.

International Society for Cell Biology

Before the War, international congresses on experimental cytology were organised by the International Society for Experimental Cytology. The International Cytological Congress held at Stockholm during July last was held under the auspices of a truncated committee of the International Society. At this Congress the old Society was dissolved, and a new Society, the Society for Cell Biology, was founded. The new Society will be responsible for future international cytological congresses. It is a member of the International Union of Biological Sciences. At Stockholm the following officers and committee were elected: *President*, Prof. J. Runnström (Sweden); *Vice-Presidents*, Dr. E. Fauré-Fremiet (France), Prof. E. Newton Harvey (United States), and Dr. G. Levi (Italy); *Secretary and Treasurer*, Dr. J. F. Danielli (Great Britain); *Committee*, Prof. T. Caspersson (Sweden), Dr. Honor B. Fell (Great Britain), Prof. A. Frey-Wyssling (Switzerland), Prof. G. C. Heringa (Holland), Prof. H. Okkels (Denmark) and Prof. Paul Weiss (United States). Many of these officers and committee members held office in the old International Society for Experimental Cytology, and Prof. Okkels was its secretary. An invitation has been received asking the new Society to hold the next Cytological Congress in the United States.

Election to membership of the new Society for Cell Biology will normally be based on original contributions to knowledge in experimental cytology and experimental histology, and related fields. One hundred foundation members were invited to participate in the formation of the new Society. These were mainly chosen from those present at the Stockholm Congress, but included a few who had given distinguished assistance to the old Society. Applications for membership of the Society for Cell Biology will be welcomed. They may be addressed to Dr. J. F. Danielli, Royal Cancer Hospital, London, S.W.3, England, or may be sent in the first instance to any officer or committee-member of the Society. Applications should normally be accompanied by a list of references to original contributions to knowledge.

International Commission on Large Dams

The first Congress on Large Dams was held in Stockholm in 1933, concurrently with the Scandinavian sectional meeting of the World Power Conference; the second was held in Washington in 1936, concurrently with the third World Power Conference. The third Congress on Large Dams will be held in Sweden next year. It will not be associated with a meeting of the parent organisation, since no meeting of the World Power Conference is planned for 1948. The organisation of British participation in this Congress is being undertaken by the British Committee on Large Dams, which is a sub-committee of the British National Committee of the World Power Conference. The general lines of the Congress will be as follows: (*a*) critical exposition of the measurement of uplift pressures and stresses arising therefrom; (*b*) research methods and instruments for the measurement of stresses and deformation in earth and concrete dams; (*c*) recent precautions to avoid the formation of pipings; (*d*) experiences arising from the testing and the actual use of special cements for large dams.

The Congress will open in the Concert Hall (Konserthuset) at Stockholm on June 10. The next two days are to be devoted to meetings, which will also be held in the Concert Hall. These meetings will be followed by a five-day study tour to a number of dams and hydro-electric power plants, and to one of Sweden's large industries. The tour includes a visit to the waterfall at Harsprånget (Hare's Leap), situated north of the Arctic Circle and in process of development (the capacity of the power station there is to be 260,000 kW.). The study tour will close with meetings in Trollhättan. Preliminary notification of intending participation must be forwarded to the Swedish Committee on Large Dams, through the Secretary, British National Committee of the World Power Conference, 201–2 Grand Buildings, Trafalgar Square, London, W.C.2, not later than December 31, 1947.

The Medical Bookman and Historian

The *Medical Historian*, believed to be the first periodical in Britain to deal solely with the history of medicine, was not able in present circumstances to appear as an independent journal. It has therefore been linked with the *Medical Bookman*, and the first issue of the new combined journal, *The Medical Bookman and Historian* (Harvey and Blythe, Ltd., 6 Hanover Square, W.1. Monthly, 2*s*.), has been published. The policy of the *Medical Historian* will be to link the history of medicine with its current practice and to try to elucidate current problems in the light of past experience and past errors. Everyone who is interested in the history of medicine will wish this new journal well and will hope that it will, before long, be able to stand by itself. Meanwhile, its fusion with the *Medical Bookman* is complete. The reader of the combined journal will, in fact, scarcely know which of the contributions belong to either partner in this interesting marriage. Eleven of the fifteen items in the list of contents of the November issue (Vol. 1, No. 11) are reviews of books, the other five being original articles; interesting as the kind of book review here printed certainly is, some readers may prefer to see by a glance at the list of contents which are the original articles and which the book reviews. Three of the articles in this issue are the first articles of a series, namely, "Bypaths in Medical Bibliography", by W. J. Bishop, librarian of the Wellcome Historical Medical Museum, "British Historians of Medicine", by F. N. L. Poynter and W. J. Bishop, and "Rise, Fall and Revivals of Hospitals", by Prof. J. A. Nixon. The other article is by the editor of the *Medical Historian*, W. R. Bett, on "Some Thyroid Pioneers". A notice on the front cover of the journal briefly reports the inaugural meeting of the new Medical Sub-section of the Library Association, which fulfils a suggestion made by Sir William Osler in 1909. The honorary secretary of this sub-section is W. J. Bishop, The Wellcome Historical Medical Museum, 26 Portman Square, London, W.1. An exchange system for duplicate or unwanted books and journals, lists of periodicals and rare books, inter-library loans and other services are contemplated. This is a development which everyone engaged in biological work will heartily welcome.

Sun-Bathing by Birds

RECORDS compiled by John Gibb (*Brit. Birds*, **50**, No. 6; June 1947) show that sun-bathing is a regular habit among passerine and predatory birds. The attitudes adopted show an obvious similarity between different species, whether the bird is facing into or away from the sun. This is typically the fluffing out of the body feathers, opening of the wings and fanning the tail. The odd postures at times may usually be attributed to the bird inclining its body towards the oblique rays of the sun. Juvenile birds are particularly prone to sun-bathing. The suggested part that sun-bathing may play in the process of moult is less clearly indicated, although the dates of records show a tendency to concentrate at times of moult.

Botanical Expedition to Nigeria

A SMALL botanical expedition, under the leadership of Dr. P. W. Richards (Botany School, Cambridge), left England on November 15 for Nigeria. The party includes Dr. G. C. Evans (Botany School, Cambridge) and Dr. E. W. Jones and Mr. J. P. M. Brenan (Imperial Forestry Institute, Oxford), and will continue work in the field until the beginning of April 1948. The chief object of the expedition is to investigate the process of natural regeneration in the evergreen tropical forest, with special reference to Aubréville's 'Mosaic Theory'. It is expected that the greater part of the work will be carried out in the forest reserves of Benin Province; but if circumstances permit, some members of the party will visit the Cameroons and make an ecological study of the little-known montane forests. The expedition has the financial support of the Royal Society and of the Colonial Research Fund.

Ministry of Agriculture and Fisheries: Appointments

THE following appointments have been announced by the Ministry of Agriculture and Fisheries: Prof. J. A. Scott Watson, chief education and advisory officer to the Ministry, formerly Sibthorpian professor of rural economy, University of Oxford, to be chief scientific and agricultural adviser to the Ministry and director-general of the National Agricultural Advisory Service, in succession to Sir William Gavin, who retires on December 31; Mr. Robert Rae, an under-secretary in the Ministry, formerly professor of agriculture in the University of Reading, to be director of the National Agricultural Advisory Service; Mr. F. Grant, principal assistant secretary in the Ministry, to be an under-secretary; Mr. H. G. Lambert, a principal in the Ministry, to take charge of a new branch to organise the special campaign for grassland development recently announced by the Minister as part of the new agricultural expansion programme, the technical officer in charge of which is Mr. W. H. Hay.

Announcements

WE regret to announce that Prof. G. H. Hardy, emeritus professor of pure mathematics in the University of Cambridge, died on December 1; on that day he should have received the Copley Medal of the Royal Society, the award of which to him was announced a short time ago.

THE Lord President of the Council has appointed Sir Frank Engledow, Draper's professor of agriculture in the University of Cambridge, to be chairman of the Food Investigation Board, Department of Scientific and Industrial Research, in succession to the late Sir Joseph Barcroft.

MR. E. A. EVANS, chief chemist to the Wakefield Group of companies since 1915, has been nominated president designate of the Institute of Petroleum for the session 1948–49. Mr. Evans has been chairman of the Motor Industry Research Association since its inception in March 1946; and was chairman of its predecessor—the Automobile Research Committee—during 1944 and 1945. In 1942–43 he was awarded the Crompton Medal of the Institution of Automobile Engineers for his paper on "Extreme-Pressure Lubrication".

THE British Social Hygiene Council is arranging a conference on "Biology in Education", to be held at University College, London, on December 30. Speakers include Prof. J. Z. Young, Mrs. F. M. Holt and Mr. W. L. Sumner. Further information can be obtained from the Secretary, British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

AN Italian Association for the Progress of Zootechny has been established at Milan, under the chairmanship of Prof. T. Bonadonna, of the University of Milan and director of the Lazzaro Spallanzani Experimental Institute for Artificial Insemination.

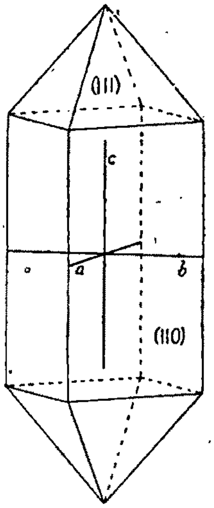
THE report of the Archæological Survey of the Union of South Africa for the period April 1940–March 1946 has appeared (Pretoria: Gov. Printer). Both in quaternary geological studies and in work on prehistoric art, there has been much activity. Dr. van Riet Lowe has had Prof. H. Breuil with him for much of the period under review, and a number of papers and other publications have been issued.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Crystal Structure of Human Carboxyhæmoglobin

Mrs. H. M. Jope kindly provided us with crystals of human carboxyhæmoglobin which she had prepared at the Department of Clinical Biochemistry, Oxford. The crystals had been grown by dialysis against 3·5 *M* ammonium sulphate solution at 0° C. and proved to be stable in 3·8 *M* ammonium sulphate solution at room temperature. They were bipyramidal prisms of almost square cross-section (see diagram); sometimes they also grew as octahedra. Birefringence was feeble compared with other protein crystals, and dichroism not detectable.



Oscillation photographs about the three principal axes showed that the crystals were orthorhombic and belonged to the space-group $P\,2_12_12_1$. The unit cell dimensions of the wet crystals are $a=85 \cdot 2$ ($\pm 0 \cdot 2$) A., $b=77 \cdot 0$ ($\pm 0 \cdot 2$) A., and $c=86 \cdot 0$ ($\pm 0 \cdot 5$) A. On drying the crystals, the cell dimensions shrink to $a=70 \cdot 4$ A., $b=73 \cdot 3$ A., and $c=77 \cdot 0$ A. (all ± 1 A.). The crystals contain four hæmoglobin molecules per unit cell. The molecular weight of the protein could not be determined directly, because the salt content of the dried crystals made measurements of the density and water content impossible. However, the close similarity between the unit cell volumes of dried oxyhæmoglobin of horse (393,000 $A.^3$)[1] and of human carboxyhæmoglobin (396,000 $A.^3$) indicates that the molecular weight of human hæmoglobin is very close to that of horse, which is known to be 66,700. The hydration of the protein in neutralized ammonium sulphate solution was determined by the method of Adair and Adair[2] and found to amount to 0·26 gm. H_2O/gm. protein.

The diffraction pattern of the wet crystals consists of sharp reflexions which extend to spacings of the order of 2·5 A., as in all wet protein crystals so far examined. In the dried crystals sharp reflexions fade out beyond spacings of about 7 A. The most interesting features of the diffraction pattern are to be found among the low-order reflexions; we know that in protein crystals these reflexions tend to be influenced by the packing of the molecules rather than their internal structure, and hence they are sometimes capable of providing a clue to the arrangement of the molecules in the unit cell. In human carboxyhæmoglobin, low-order reflexions tend to be either faint or absent unless $h+k$, $h+l$ and $k+l$ are all even; this tendency is most marked among the $h0l$ reflexions and can also be seen to a certain extent among the $hk0$'s and $0kl$'s. It is limited to reflexions with spacings greater than 30 A. This distribution of intensities indicates that the hæmoglobin molecules lie approximately at the corners and face-centres of the unit cell, an arrangement which is compatible with the space-group symmetry; for if one molecule is placed at $x=y=z=0$, the other three molecules in the unit cell would have to lie at the centres of the three faces. Since the edges of the unit cell have almost equal lengths, this brings the molecules very close to the positions of cubic close packing, an arrangement which is all the more likely in view of the octahedral habit of the crystals. It follows that the molecules themselves must be practically isodiametric.

The low optical anisotropy of the crystals indicates that the relative orientation of the four molecules in the unit cell is such as to lead to mutual compensation of the intrinsic molecular anisotropies. This was confirmed by the results of Patterson projections which were prepared along the three principal axes for both the wet and air-dried states of the crystals. These projections showed far more complex peak systems than, for example, horse methæmoglobin[3] or insulin[4], and attempts to find structural features which could be compared with those of other proteins were fruitless on account of the bewildering mass of similar vector peaks occurring in all projections. As in all protein crystals so far examined, there are concentrations of peaks in the region of 10 A.; but this fact by itself does not provide any useful clues regarding the structure of the molecule. It is difficult even in crystals which contain only one protein molecule per lattice point, to derive conclusive information about the intra-molecular structure from the X-ray data. If several molecules are present, and if each of them, moreover, is oriented differently with respect to the crystal axes, as in human carboxyhæmoglobin, the problem soon reaches a prohibitive order of complexity. The chances, therefore, that further analysis of the present structure would lead to fruitful results must be considered remote.

Our crystals were identical in habit with those described by Drabkin and classified by him as tetragonal[5]. Without further data it will be difficult to decide whether Drabkin's crystals represent a different polymorphous modification of the same protein, or whether possibly Drabkin was misled by their pseudo-tetragonal character and his crystals are actually identical with our orthorhombic ones.

Of other derivatives of human hæmoglobin which were examined, oxyhæmoglobin was found to be isomorphous with carboxyhæmoglobin. Methæmoglobin crystallizes in tetrahedra which are probably isomorphous with the octahedral carboxyhæmoglobin crystals examined here, one half of the octahedral faces being undeveloped. Reduced hæmoglobin, on the other hand, crystallizes both as strongly birefringent plates and as bipyramidal prisms the symmetry of which has yet to be found. Finally, it may be worth mentioning that the structure of the carboxyhæmoglobin crystals was the same no matter whether they were crystallized from ammonium sulphate or potassium phosphate solution.

We are very grateful to Mrs. H. M. Jope for having made this investigation possible by providing us with beautifully large, well-developed crystals.

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Olga Weisz

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Sept. 16.

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Metabolism of Synthetic Œstrogens in Man

It has long been the practice in carrying out phenol metabolism experiments in animals to measure the increase in ethereal sulphate excretion above the normal average to give an indication of the extent to which the phenol in question is being excreted by sulphate formation. Similarly, a rise in conjugated glucuronic acid excretion above the normal average is taken as proof that the material is being 'detoxicated' by glucuronide formation. In many cases it has been possible to obtain figures by this method upon which rough quantitative metabolic data could be based.

However, in view of the large natural daily variation of both ethereal sulphate and glucuronide excretion in the urine, it is only possible to make use of the above method when relatively large amounts of phenol (or other substance) are to be metabolized. There is some evidence, especially in the case of synthetic œstrogens (unpublished results), that large overdosing alters the metabolic path, in that unchanged phenol is excreted. Here large overdosing is likely to give a distorted view of the metabolism, even though the estimation method may be made workable by this means. Obviously, information on the metabolic path taken under normal therapeutic dosing is not necessarily obtained by the method.

In the rabbit, according to Bray, Ryman and Thorpe[1], the normal daily excretion of ethereal sulphate in the urine varies from 10 to 38 mgm. If stilbœstrol, for example, were excreted as its monosulphate, this normal sulphate figure would account for a blank stilbœstrol value of 34–130 mgm. daily. In the case of human urine, the daily excretion of ethereal sulphate may vary from 10 to 250 mgm., corresponding to a daily blank value of 34–840 mgm. stilbœstrol. Since the therapeutic dose of this substance varies from a fraction of a milligram to 50 mgm. daily, and as even 50 mgm. would increase the ethereal sulphate figure by only 15 mgm. (30 mgm. if disulphate were excreted), it is obvious that the metabolism of stilbœstrol in the human subject cannot be studied conveniently by ethereal sulphate determinations.

The same considerations apply to the use of glucuronic acid determinations for following glucuronide formation in metabolism experiments in the human subject.

In order to carry out the experiments on synthetic œstrogen metabolism in therapeutic doses in animals and man at present being conducted in this Institute, it has been necessary to devise chemical separation methods checked by bioassay[2,3,4]. This, too, has disadvantages, yet they are considered less than those outlined above.

Although it has not yet been possible to isolate either the œstrogen glucuronide or the sulphate ester from the urine of patients treated with stilbœstrol or hexœstrol, on account of the small dosages used, yet indirect evidence points to a monoglucuronide excretion of as much as 50 per cent administered œstrogen and a sulphate ester excretion up to 6 per cent. In most cases less than 1·0 per cent œstrogen was excreted in the free form. It was formerly thought that large proportions of synthetic œstrogens administered to man were degraded to completely inactive products.

Full details will be published elsewhere.

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Aug. 20.

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A New Blood-Pressure Principle of the Anterior Lobe of the Pituitary

Hitherto only the posterior lobe of the pituitary was known to contain a blood-pressure principle generally called vasopressin. Its role in the circulation system is not defined, and it is not held to be of great importance. As for the anterior lobe of the pituitary, no blood-pressure factor has been found, although some clinical evidence has pointed to its existence; for example, diseases of pituitary origin like acromegaly, Simmonds disease, Cushing syndrome, and Fröhlich disease are very regularly accompanied by blood-pressure anomalies. Moreover, it has been demonstrated that hypophysectomy in animals leads to low blood pressure. However, as some hormones of the adrenals, such as the adrenalin and the desoxycorticosterone group, have effects on blood pressure, and adrenalectomy is known to be followed by a much lower degree of blood pressure than hypophysectomy, attention has been directed hitherto to the hormones of the adrenals. Another reason for neglecting the pituitary in this respect arose out of the problem connected with the Cushing syndrome, which was increasingly regarded as being related to the adrenals rather than the pituitary.

Clinical observations, the details of which will be given elsewhere, have convinced us that the anterior pituitary lobe must contain a blood-pressure factor which has its share in the regulation of blood pressure not only in pathological but also in physiological circumstances. After extensive experimental work we succeeded in extracting from ox pituitaries a principle which was able to raise to normal levels the blood pressure in rats rendered artificially hypotensial by adrenalectomy. We employed the non-bloody method of Byron and Wilson, which allows

TABLE 1

	Blood pressure before operation	Blood pressure after operation
Rat 1	135 mm. Hg	85 mm. Hg
Rat 2	130 „ „	80 „ „
Rat 3	140 „ „	95 „ „
Rat 4	135 „ „	90 „ „

repeated measurements with the same animal, thus making possible comparable pressure readings on consecutive days. In addition, this method permitted us to determine the duration of the pressure effect and to learn whether, after its disappearance, it can again be reproduced by repeated injections. As an example, we submit some short-term observations made with four adrenalectomized rats, while a fuller account with larger numbers in a modified arrangement will be given in another paper.

Table 1 shows the average blood pressure of each rat taken before and after adrenalectomy and determined by at least five measurements. The injections begin on the second day after adrenalectomy and are continued once a day as long as the rat survives. Considering the fact that the rats cannot be given life-prolonging extracts like adrenal hormones, in order to exclude any mistake with respect to the substance tested, and furthermore taking into account the weakening effect of prolonged narcosis, indispensable in this pressure method, the survival period is only six to eight days. The effect of the injections is observed one to two hours after each injection. The next day the rat is left without an injection and its blood pressure is determined. On the following day another injection is given and its effect observed, and so on until the death of the animal. As may be seen from Table 2, the full pressure effect does not last twenty-four hours, but the blood pressure does not revert to the original low level before treatment. That there is a cumulative effect can be seen from a comparison of the figures in the interval between two injections.

A more detailed paper will give evidence that the remaining mother substance, from which the blood-pressure principle was obtained by dialysis through a 'Cellophane' membrane, did not show any pressure properties. Its passage through colloidal filters indicates a small molecular size of this principle. Its chemical nature has not yet been ascertained, but it seems to belong to the amino-acid group. It could be separated from other pituitary hormones by fractionated dialysis preceded by an acid hydrolysis of ox pituitary (lobe anterior). The concentration used was 1 gm. of fresh gland material, corresponding to 1 c.c. of the final extract.

The effect of this hypophyseal factor is quite different from that of vasopressin and adrenalin. Contrary to these, it does not have an immediate effect but within one or two hours later, and above all it is of lasting and cumulative character. It has more resemblance to the pressure effect of the desoxycorticosterone group, but it differs from the latter in its stronger and more distinct action Preceding the experiments with adrenalectomized rats, we tested this principle with the object o differentiating it from gonadotropin and adrenocorticotropin. Contrary to adrenocorticotropin, i had no stimulating effect on the adrenal cortex and no adrenal enlargement could be recorded b the usual methods.

TABLE 2. BLOOD-PRESSURES (MM. MERCURY)

	First injection		Second injection		Third injection		Fourth injection
	After 2 hr.	After 24 hr.	After 1 hr.	After 24 hr.	After 1 hr.	After 24 hr.	After 2 hr.
Rat 1	125	90	125	110	125	110	125
Rat 2	115	100	125	105	120	120	dead
Rat 3	130	110	140	115	140	dead	
Rat 4	130	110	140	115	140	dead	

From our observations, we arrived at the following conclusions :

(1) The anterior lobe of the pituitary contains blood-pressure principle.

(2) It seems probable that this principle is th cause of blood-pressure anomalies met in certai diseases of the anterior pituitary lobe.

(3) There are indications that this factor has it share in the normal control of blood pressure ; thi would mean that the regulation of blood pressure i partly hormonal.

These investigations were carried out in th laboratories of the Teva Chemical Works, Jerusalem

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July 11.

Influence of Hypophyseal Hormone and o Nervous Impulses on the Colour-dress o Hermaphrodite Teleostean Fish

INJECTION of extracts of the posterior pituitar gland evokes the brilliant colours of the 'nuptia dress' in *Phoxinus lævis*[1] and some marine teleosteans The active principle, intermedin, is produced in th intermediate lobe of the hypophysis[1] and its secretio is probably controlled by a hypothalamic centre In *Phoxinus lævis*, localized destruction of particula regions of the spinal cord delays or inhibits th reaction. From this, some authors[2,4] have conclude that the hormone affects the chromatophores not onl peripherally but also via the central nervous system Others think it more probable that the result c this operation came about through oxygen-want, an that the lipophores of a fish's skin, unlike the melanc phores, are without innervation[5].

The following experiments, carried out on a Adriatic perch, *Serranus scriba*, show the particula sensitivity of the lipophores to intermedin and t nervous impulses. The experiments, save for on series, were performed outside the spawning seasor The fish were kept under approximately equal cor ditions of lighting, oxygenation and temperature The active substances, with one exception, wer dissolved in 0·10 ml. of physiological saline c Ringer's solution and injected subcutaneously i the dorsal region. Specimens injected with saline c Ringer's solution were used as controls.

In *Serranus scriba*, unlike *Phoxinus lævis*, exhibitio of the 'nuptial dress' is not confined to a particula season : many individuals wear the characteristi coloration outside the spawning season. When suc a fish was caught, the 'nuptial dress' often disappeared reappearing later in the aquarium. This phenomeno is not caused by oxygen-want ; for the bright colour frequently disappeared temporarily when the fis were chased about in the oxygenated water, bu persisted after pithing, or after paralysis of th respiratory centre by 0·40 mgm. of atropine sulphate

The effect of excitation appeared more or less immediately and, therefore, is probably a result of direct nervous stimulation. It is questionable whether, in addition, secretion of endogenous adrenalin takes place during excitation. The effect could be reproduced by adrenalin hydrochloride or by 0·05–0·50 mgm. of acetylcholine chloride, which is known to stimulate the adrenal medulla[6]. But the adrenalin was effective only in doses of 0·10 mgm. or more and the individual responses to acetylcholine varied in intensity. 0·20–0·60 mgm. of the sympathomimetic tyramine also caused fading of the 'nuptial dress'; the effect appeared 15–45 minutes after injection, the fish remaining pale for about two hours.

We found, like Fleischmann and Kann, that posterior pituitary extracts evoked the 'nuptial dress' within 10–20 minutes after injection. Doses of 0·50–1·00 I.U. of a whole extract, 0·05–0·10 I.U. of a fraction with predominantly pressor-activity, or 2·00 I.U. of a predominantly oxytocic fraction were effective. The figures show that, on fractionation, the intermedin mainly passes into the pressor-fraction.

In *Serranus scriba* the hormone acts on the lipophores peripherally[2]. Nevertheless, removal of the brain orally from the optic lobes, which affected respiration for a few minutes only, inhibited the response of the erythrophores while that of the xanthophores was somewhat enhanced. This result suggests that the chromatophore response to the action of the hormone may be influenced by the central nervous system. Atropine sulphate, though paralysing the respiratory centre, did not reduce the hormonal effect; the latter seemed actually to be increased in some specimens. Hypophyseal extracts and tyramine inhibited one another in their actions on the colour-dress.

In *Serranus scriba*, pressure on the roof of the pharynx produces no colour-change[2], while in *Phoxinus* this manipulation produces the 'nuptial dress' by release of intermedin[5]. We repeated this experiment on *Serranus scriba* during the spawning season and at various other times of the year, with the same constantly negative result. Furthermore, we injected individuals which were not in 'nuptial dress' with a suspension of *Serranus*-pituitaries in Ringer's solution. These injections produced no colour-change, whether the donors were in 'nuptial dress' or not. It follows from this that the hypophysis of *Serranus scriba*, of which the lipophores are so sensitive to intermedin, does not produce this hormone. Moreover, injection of 0·50 ml. of pregnant urine on two consecutive days, representing a total dose of about 15 M.U. of chorionic gonadotrophin, did not influence the coloration. This result agrees with that obtained by Fleischmann and Kann, who found that gonadal hormones produce no colour-change in *Serranus scriba* although they do so in the bitterling. These peculiarities become comprehensible when one recalls that this fish, unlike the minnow and the bitterling, is hermaphrodite. Its 'nuptial dress', therefore, represents no sex function, and consequently is not caused, under physiological conditions, by a sex gland. In this connexion, it may be of interest that in *Serranus cabrilla*, a closely related perch, the 'nuptial dress' is much less conspicuous than in *S. scriba* and cannot be produced by intermedin.

This letter is an account of work carried out in the Oceanographic Institute, Split, in 1938–39, its earlier publication having been prevented by the War. One of us (O. P.) gratefully acknowledges the hospitality shown him by the members of the Institute.

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Phylogenesis of the Perivascular Spaces of the Brain

According to recent investigations by Van Rijssel[1] on a species of carp (*Carassius Gibelio*), the perivascular spaces penetrate throughout the brain. Cerebrospinal fluid circulates in the spaces, and thus the external and internal liquors mix. This circulation goes in the same direction as the blood circulation and is created by the pulse wave.

In my experiments, I injected a 1 per cent trypan blue solution into the cranial cavity and the ventricles of different vertebrates. In fish (*Leuciscus rutilus*, *Abramis brama*, *Aspius rapax*, *Perca fluviatilis*) I found, in conformance with Van Rijssel's observations[1], that the channels surrounding the blood vessels penetrate throughout the whole of the brain substance and bring about a connexion between the surface and the ventricles of the brain. This channel system is best defined in the pallium, which is densely interwoven with a network of perpendicular blood vessels. I made similar observations in amphibians (*Rana esculenta*, *Rana ridibunda*).

Among the reptiles, I investigated the brains of lizards (*Lacerta viridis*). Their hemispheres are more strongly developed, and the perivascular channel system penetrating the brain is very marked (Fig. 1). The liquor externus appearing in Teleostii is represented in reptiles by a continuous layer of fluid around the brain, increasing the significance of the perivascular spaces. The arteries enter from the surface of the brain or from the inter-hemispherical fissure and penetrate the substance of the brain perpendicularly.

They turn again at right angles on reaching the ventricle, and in the subependymal layer they continue

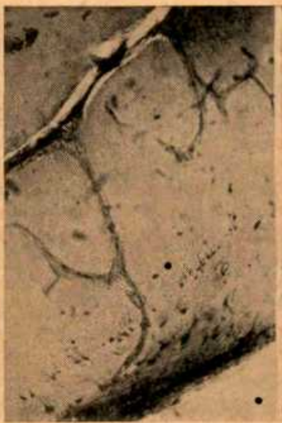


Fig. 1

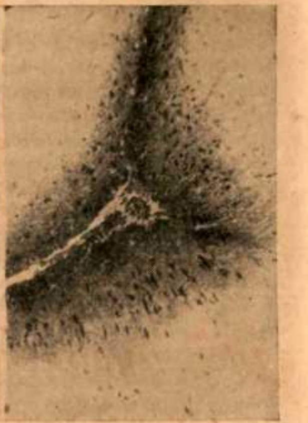
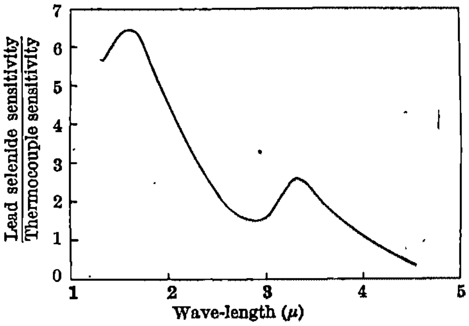


Fig. 2

Lead Selenide Cells for Infra-Red Spectroscopy

THE advantages of lead sulphide cells[1] as detectors in infra-red spectrometers have already been described[2] for the region between 1 and 3 μ. Although it appears that the useful range of these cells may be extended slightly by working at liquid air and liquid hydrogen temperatures[3], it seemed to us more profitable to explore further the possibilities of lead selenide cells as a means of extending the range of photoconductive methods in the infra-red. Reports of war-time work in Germany indicated that lead selenide had a peak sensitivity near 3·4 μ as compared with the lead sulphide peak near 2·6 μ; but no figures have been available on the actual performance of these German cells, relative to some standard such as a good vacuum thermocouple. The fact that lead selenide cells never got beyond the laboratory stage in Germany would seem to indicate that progress there had not reached the stage where the lead selenide cell was superior to the thermocouple or bolometer.

We have recently made lead selenide cells by the method outlined by Simpson[4] which are superior to a Hilger–Schwarz thermocouple, at least as far as 4 μ, and have a time of response which is well below 50×10^{-6} sec. These have been tested in a prism spectrometer (lithium fluoride prism) of high resolving power against a first-rate Hilger–Schwarz vacuum thermocouple as standard. By comparing the slit widths necessary to give the same signal/noise ratio when the thermocouple has a 'Pyrex' window in front, of comparable thickness to the base of the lead selenide cell, we obtained the sensitivity curve shown in the graph. It will be observed that the lead selenide cell has two maxima of sensitivity, one near 1·6 μ and the other near 3·3 μ, the former being considerably the higher of the two. The factors controlling the relative heights of these two maxima have not yet been elucidated.



Although the lead selenide cells so far made are inferior in performance to lead sulphide cells (comparing absolute sensitivities at their respective maxima) we have no reason to believe that the optimum method of preparation and usage has yet been achieved. These preliminary results are, however, most encouraging, and even if no further improvement is obtained the present lead selenide cells are an important advance on the lead sulphide cell. The extension of the usable range from 3 μ to 4 μ means that virtually all absorption bands due to the stretching vibrations of hydrogen atoms can be examined with a much higher resolving power and at much greater speed than was previously possible. The 'Pyrex' envelope now used is admittedly a drawback in that its absorption limits the effective range to 3·4 μ, but we have found that a quartz envelope gives an improvement, and it is hoped that a suitable window can be arranged for the base of the envelope to enable the full range to be exploited.

We are indebted to the Admiralty and to the Telecommunications Research Establishment at Malvern for the loan of equipment used in making and testing these cells.

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Interaction Terms in Molecular Vibrations

WE have recently been investigating the magnitudes and signs of the interaction terms in the potential functions of triatomic molecules *XYZ*. These arise from interactions between two bond-lengths (*XY* and *YZ*), or between one bond-length and the angle *XYZ*. In our study of these terms we have distinguished three distinct effects: (1) resonance effects; (2) interaction between non-bonded atoms (here *X* and *Z*); (3) changes of hybridization at the central atom (here *Y*). A proper understanding of all three of these is necessary before even the signs of the interaction terms can be adequately explained.

An example of each of these three effects may be given.

(1) The resonance effect is shown in the linear molecule N—N—O, where the chief resonating structures are I and II,

$$\overset{-}{N}=\overset{+}{N}=O \qquad N\equiv\overset{+}{N}-\overset{-}{O}$$

(I) (II)

and the wave function is

$$\psi = \psi_I + \lambda\psi_{II}.$$

If, now, the N—O bond-length is increased (by Δr_1), ψ_{II} is favoured energetically, so that λ is increased and the structure II acquires greater importance. This means, as has been mentioned elsewhere[1], a shortening of the N—N bond (by Δr_2) and consequently a positive f_{12} in the potential energy expression for linear vibrations:

$$2V = f_1 \overline{\Delta r_1}^2 + f_2 \overline{\Delta r_2}^2 + 2 f_{12}\, \Delta r_1\, \Delta r_2.$$

This sign for f_{12} agrees with the vibration spectrum[1].

(2) The interaction between non-bonded atoms is shown in the linear molecule H—C≡N. Here the dipole moment for both bonds is directed in the same way (+→), so that H is positively charged and N is negatively charged. There is, therefore, a strong attraction between them. It can be shown that this leads to a negative value of f_{12}, in agreement with experiment[2].

(3) The changes in hybridization at the central atom are illustrated by the water-molecule H—O—H.

In the equilibrium configuration the HOH angle is about 104° 31′, and there is very little *s*, and almost all *p*, in the hybridized oxygen orbital from which the O—H bond is formed. But if the angle is increased, it can be shown[3] that the amount of *s* increases and consequently the new equilibrium bond-length decreases. This implies that in the potential energy formula,

$$2V = f_1\,[\overline{\Delta r}_1{}^2 + \overline{\Delta r}_2{}^2] + 2f_{12}\,\Delta r_1\,\Delta r_2 + r_1 r_2 f_\theta\,\overline{\Delta\theta}^2 + 2r_1 g_c\,(\Delta r_1 + \Delta r_2)\,\Delta\theta,$$

the bond-angle interaction constant g_c has a positive value. This again is in agreement with observation[4].

It is worth while noticing furthermore that we have been able to show that the contributions to the interaction constants f_{12} and g_c that arise from the force between the two non-bonded atoms have the same sign, though this sign is negative when the force is attractive and positive when it is repulsive.

In general, two or more of the effects (1)–(3) above will act at the same time. But it is often possible to predict the sign and approximate magnitude of the interaction constants: and if these constants have been determined experimentally, we are able to interpret them in terms of more fundamental notions, namely, the description of electron behaviour by means of (1)–(3).

A full account of this work will be published later.

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Nuclear Forces and the Magnetic Moment of the Deuteron

RECENTLY[1] the magnetic moments of the proton, neutron and deuteron have been measured with great precision. It is found that the moment of the deuteron differs from the algebraical sum of the moments of the proton and neutron by an amount much greater than the experimental error. The discovery of the electric quadrupole moment of the deuteron[2] in 1939 already indicated that the ground-state of the deuteron is not of pure ^3S character but contains an admixture of ^3D. The observed magnetic moment can be explained if the percentage admixture is 4 per cent. If it can be assumed that relativistic effects are unimportant[3], use may be made of this accurate figure to obtain further information about the neutron-proton interaction. Following the method of Rarita and Schwinger[4] we have taken this to be of the form

$$V(r, \sigma_1, \sigma_2) = -\{(1 - \tfrac{1}{2}g) + \tfrac{1}{2}g\vec{\sigma}_1.\vec{\sigma}_2 + \gamma S\}Cf(r/a),$$

where

$$S = \frac{3\vec{\sigma}_1 . \vec{r}\,\vec{\sigma}_2 . \vec{r}}{r^2} - \vec{\sigma}_1 . \vec{\sigma}_2,$$

$\vec{\sigma}_1$, $\vec{\sigma}_2$ being the spin vectors of the respective nucleons and r their relative co-ordinate. This interaction involves four constants, g, γ, the range a and the strength C of the radial function $f(r/a)$. For a given function, f, the constants may be fixed completely from the collision cross-section of thermal neutrons with protons, the binding energy and quadrupole moment of the deuteron, and the new precise values of the magnetic moments.

Column (*a*) in the accompanying table gives the range derived in this way for four forms of the function $f(r/a)$—the spherical well $f(r/a) = 1$, $r < a$; $= 0$, $r > a$, the Gaussian potential $\exp(-r^2/a^2)$; the Yukawa potential $\{\exp(-r/a)\}(a/r)$; and the exponential potential $-\exp(-2r/a)$. The value for the spherical well case has already been obtained by Rarita and Schwinger[4]. The inclusion of an exchange operator in the function has no influence on these results.

Independent evidence concerning the range may be obtained by choosing a different quantity in place of the magnetic moment to complete the determination of the four constants. The first of these, which gives the ranges in column (*b*) of the table, is the cross-section for elastic collisions of 1–6 MeV. neutrons with protons[5]. In this case the presence or otherwise of an exchange operator does modify the results. The ranges we have given have been obtained with such an operator included. They would otherwise be smaller.

Assumed force law	(*a*) From magnetic moments	Derived range in 10^{-13} cm. (*b*) From scattering of 1–6 MeV. neutrons by protons	(*c*) From proton-proton scattering	(*d*) From triton binding energy
Spherical well	2·8	2·45±0·1	2·8	
Gaussian	1·9±0·15	—	1·94	2·22[7]
Yukawa	1·4±0·05	1·8 ±0·05	$1{\cdot}18_5$	$1{\cdot}83_5$[7]
Exponential	1·6±0·05	1·75±0·05	1·73	1·73[8]

In column (*a*) the errors assigned allow for inaccuracy in extrapolation of calculated results; in column (*b*) for experimental error.

If it is assumed that the force between two nucleons is the same whether they are like or unlike, the anomalous scattering of protons by protons or the binding energy of the triton may also be used to provide the fourth relation necessary to fix the range. The ranges obtained from proton-proton scattering by Hoisington, Share and Breit[6] are given in column (*c*) of the table, and those from the triton binding energy in column (*d*). In neither of these cases does the result depend on the presence or otherwise of an exchange operator, but the binding energy calculations have assumed the forces to be central[9] and of exclusively two-body character. (The binding energy of He[4] seems to be slightly too large when calculated with the assumed ranges of column (*d*) (see refs. 8 and 9). This may indicate the presence of repulsive many-body forces.)

It will be seen that, while the results of the different methods are reasonably consistent for three of the radial forms assumed, the Yukawa potential appears quite unsatisfactory in this respect.

A detailed account of this work, including a discussion of the photo-disintegration of the deuteron and the angular distribution of protons projected by neutrons in the range 2–20 MeV., will be submitted shortly for publication in the *Proceedings of the Royal Society*.

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Crystal Structures of Zinc and Magnesium Benzene Sulphonates

A RECENT note by A. Hargreaves[1], of the Physics Department, College of Technology, Manchester, summarized the information obtained from a projection, along the b-axis, of the electron density in the unit cell of zinc p-toluenesulphonate. An investigation of the structures of the closely related zinc and magnesium benzene sulphonates, begun by one of us (A. D. I. N.) at Manchester at the suggestion of Dr. Hargreaves and with his assistance, has now been completed in this Laboratory. The positions of all the atoms in the unit cells have been determined by Fourier syntheses of projections of the electron density along the b- and c-axes. The crystals used in this analysis were twinned across the face (100), with the consequence that reflexions (h00) of the twin components overlapped completely, (h05) reflexions were superposed, and there was partial overlap of reflexions (h04) and (h06). Some reduction in the accuracy of the b-axis projection results from the necessity for applying a correction to the observed intensities of these overlapping reflexions.

As was expected, the structures of the benzene sulphonates prove to be essentially similar to that suggested for zinc p-toluenesulphonate by Hargreaves from his partial determination of the structure by means of the single projection along the b-axis. The metal atoms are surrounded by regular octahedra of water molecules, and the metal-to-water distances are in accordance with accepted values of the atomic radii. The benzene ring is plane and the average distance between the carbon atoms is 1·40 A. The sulphur–oxygen bond distance in the sulphonate group is 1·41 A., and the sulphur atom is linked to the benzene ring by a bond of length 1·89 A. in the magnesium compound and 1·81 A. in the zinc compound, the difference probably representing experimental error. The distribution of bonds about the sulphur atom appears to be regular tetrahedral, the bond angles in both compounds being approximately 109°.

The analysis, and details of the structure, will be published elsewhere.

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A Rapid Method of Analysis for Certain Surface-Active Agents

THE fact that certain cationic surface-active agents, such as cetyl pyridinium bromide, form stoichiometric salts with anionic surface-active agents such as the alkyl sulphates, alkyl sulphonates and alkyl aryl sulphonates, has been used as the basis of two titrimetric methods of analysis of the latter materials. That of Hartley and Runnicles[1] uses bromphenol blue as an indicator to detect when excess cation-active material has been added, while that of Preston[2] uses a remarkable surface tension change to mark the end-point. Unfortunately, neither method of determining the equivalence point is completely satisfactory. In the first case the colour change is not sharp, and in the second the point at which the surface tension change occurs is affected by the presence of inorganic salts.

In this laboratory we have developed a new method of end-point detection which gives accurate and reproducible results even in the hands of relatively unskilled personnel and under a wide variety of conditions, and does not suffer from the above defects. The method is based on observations by Jones[3]. He showed that whereas the chloride of the basic dyestuff methylene blue is insoluble in chloroform, the alkyl sulphate and related salts are freely soluble and may be extracted quantitatively from aqueous solution by chloroform provided that the chain-length of the organic portion is sufficiently large. (This fact was made the basis of a colorimetric estimation.) However, the extraction is almost completely inhibited if the aqueous phase contains a quantity of cation-active agent more than equivalent to the anionic material present. This is because the colourless cetyl pyridinium alkyl sulphate is more soluble in chloroform and is extracted in preference to the methylene blue salt. The blue colour therefore remains in the upper aqueous layer.

In the new titrimetric method, 10 ml. of an alkyl sulphate or other similar surface-active agent (approximately 0·004 M) is pipetted into a 250-ml. stoppered reagent bottle. 25 ml. of aqueous indicator solution containing 0·003 per cent methylene blue (B.P.), 1·2 per cent sulphuric acid and 5 per cent sodium sulphate are added, followed by 15 ml. chloroform. A solution of cetyl pyridinium bromide (approximately 0·004 M) is then added from a burette. After each small addition of the latter the mixture is shaken. At first the blue colour concentrates in the chloroform layer, but as the titration proceeds there is a slow transfer of colour to the water layer. Later the rate of transfer increases, and eventually the colour of the two layers is visually the same. This is found to be the equivalence point. On further addition the chloroform layer lightens in shade, and becomes colourless.

The fact that the point at which the two layers have the same colour is the equivalence point has been exhaustively confirmed by titrating solutions of some pure sodium alkyl sulphates and many other similar substances of known purity with a cetyl pyridinium bromide solution, the strength of which had been determined by precipitation of its dichromate salt with excess potassium dichromate[4].

The end-point is surprisingly sharp and can be reproduced to 0·1 ml. after a little practice. It is not affected by the presence of excess inorganic salt, acids, moderate quantities of organic solvents, commonly occurring temperature variations, or reasonable departures from the experimental conditions described above.

Substances with chain-lengths greater than C_8 can be determined accurately, but the longer the chain-length the sharper the end-point. Oil-soluble surface-active substances of very long chain-length insoluble in water can be determined by making up the standard solution in chloroform and proceeding as before, except, of course, that the volume of chloroform solution added is measured accurately. Fatty acid soaps and substances having more than one ionizable group cannot be estimated by the method, but their presence does not interfere with its operation with materials to which the method otherwise applies.

A full account of this work will appear shortly elsewhere[5].

I wish to thank the "Shell" Refining and Marketing Co., Ltd., for permission to publish this work, and Messrs. P. J. Garner and S. L. Levy for helpful advice and suggestions.

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Reaction of Nitrous Acid with Chlorophyll

Nitrous acid has been found to react readily with chlorophyll, giving four highly coloured crystalline compounds. The reaction was carried out as follows: 10 gm. of chlorophyll (commercial powder) was dissolved in 300 ml. of chloroform and 200 ml. of 3 per cent hydrochloric acid added; 12 gm. of sodium nitrite in 50 ml. of water was then added, with vigorous shaking, over a period of half a minute. The chloroform layer, which underwent a striking colour change from green to dark red, was separated immediately and washed with water. Evaporation of the solvent left a crystalline mass (10 gm.) from which the compounds *A*, *B*, *C* and *D* were obtained

Separation of the Products. *A* and *D* were adsorbed on activated alumina from a chloroform solution of the reaction products. On development with chloroform, *A* formed a red band of its aluminium salt and *D* a yellow band. These bands were separated and the organic constituents obtained from them by boiling with dilute aqueous sodium carbonate, filtering and acidifying the filtrates. *B* and *C* were not adsorbed and were separated by means of boiling 50 per cent alcohol, in which *B* only was soluble. 10 gm. of chlorophyll gave: 1–1·5 gm. of *A*; 3–5 gm. of *B*; 1·5–2 gm. of *C*; and 0·03 gm. of *D*.

Purification. *A* was purified by recrystallization from chloroform – absolute alcohol. *B* was either (i) dissolved in boiling *N*/5 caustic soda and reprecipitated with dilute hydrochloric acid, or preferably (ii) sublimed at 100° C. (20–30 mm. pressure). *C* was crystallized from glacial acetic acid, and then further purified by crystallization from chloroform – absolute alcohol. *D* has not yet been obtained in pure form.

Properties of the Reaction Products. The physical and chemical properties of the substances and the formulæ assigned to them are listed in the table.

Property	*A*	*B*	*C*	*D*
Colour	Indian-red in reflected light, pale yellow-green in transmitted light	Crimson	Indigo	Amber
Crystalline form	Prisms	Needles	Needles	Plates
Odour	Odourless	Smell like *o*-nitrophenol	Odourless	Smell like *o*-nitrophenol
Volatility	Non-volatile	Sublimes and steam-distils	Non-volatile	—
Melting point (corrected	151–153° C.	103·5–105° C.	219–222° C.	(18–28° C.)
Solubility in ordinary organic solvents	Soluble	Soluble	Soluble	Soluble
Solubility in water	Insoluble	Insoluble	Insoluble	Insoluble
Solubility in alkalis	Soluble	Soluble	Insoluble	Soluble
Solubility in 50 per cent ethanol	Soluble	Soluble hot	Insoluble	Insoluble
Tautomerism	Acid-alkali forms	Acid-alkali forms	No tautomerism observed	—
Salt formation	Potassium salt, no sodium salt, no platinichloride	No salts	No salts	—
Reaction with acetic anhydride	Mono-acetyl derivative, orange prisms, m.p. 113·5–115° C.	Mono-acetyl derivative, deep orange prisms, m.p. 76–79° C. DD	No acetyl derivative	—
Formula assigned	$C_{14}H_{13}N_3O_3$	$C_{14}H_{16}N_2O$	$C_{13}H_{10}NO$ or $C_{12}H_{11}NO$ (empirical formula)	—

The compounds *A*, *B* and *C* appear to be tetra-substituted pyrrole derivatives. Further work on the structure of the compounds will be undertaken.

This investigation originated from previous work in South Africa on *Tribulus* poisoning ('geeldikkop') in sheep, associated with symptoms of jaundice and photosensitization. Full details will be published in the *Onderstepoort Journal of Veterinary Science and Animal Industry*.

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Aug. 2.

Occurrence of Microflora in the Salt Pseudomorph Beds, Salt Range, Punjab

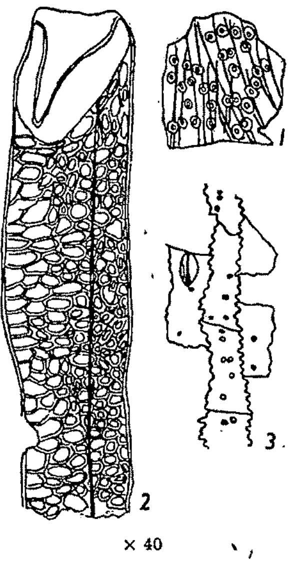
The age of the Punjab Saline Series is still a vexed problem in Indian geology. Gee[1,2,3,4] and Fox[5], to whom we are indebted for much of our geological knowledge of this area, have assigned a 'Cambrian' or 'pre-Cambrian' age to this series. Sahni[6,7,8] and Sahni and Trivedi[10,11], on the other hand, from the evidence of such microfossils, for example, woods of conifers, cuticles of grasses, angiospermous wood elements, etc., and their repeated occurrence at widely different localities, are against a 'Cambrian' or 'pre-Cambrian' age. Two lively symposia were held in December 1944 and 1945 at Poona and at Udaipur, respectively, and a vast literature has accumulated on the subject[8,9,12].

In view of the great scientific importance of the problem a field-party of geologists visited critical sections in the Salt Range in 1944 and re-examined the field evidence in the light of the microfossil data. Their unanimous verdict is that an Eocene or later age for the Saline Series, as suggested by Sahni and others, is irreconcilable with the field evidence, although they were unable to offer any explanation on the occurrence of minute plant fragments of 'post-Cambrian' age in the dolomites and oil shales[13].

We are carrying out investigations on the Salt Range microfossils and have already examined several rocks from the Saline Series of the Dandot overfold, Makrach, Khewra and various other localities. Following the maceration technique, the microfossils recovered from these include: (1) scalariform tracheid of a certain pteridophyte, (2) bordered pitted tracheid of conifer, (3) vessels of angiosperms, (4) libriform fibres of higher dicotyledons, and (5) cuticles. Thus our findings are not all new in relation to the discoveries of Sahni, and far from contradicting him, they firmly support his views regarding the occurrence of such plant-remains in the Saline Series.

But the chief interest in our work lies in the occurrence of a few microfossils in the Salt Pseudomorph Beds, which were so long regarded as unfossiliferous. The argillaceous, fine-textured sandstones and sandy dolomite analysed from this series came from Chittidil, and the microfossils recovered are again mainly those which suggest a Tertiary age. The microfossils recovered from these Salt Pseudomorph strata include wood elements of conifers and angiosperms, cuticles, spores, etc. The following is a provisional list.

(*a*) *Wood elements* (seven types). Tracheids uniseriate to biseriate with bordered pits (coniferous), and scalariform thickening with rays (pteridophytic); angiosperm vessels with alternate pitting, overlaid internally by tertiary thickenings (dicotyledonous) (Fig. 1) or crowded and thus becoming angular due to lateral contact (Fig. 2); wood parenchyma with simple pitting and of isodiametric dimension (coniferous) or of longitudinal cells grouped in series.



× 40

(*b*) *Cuticle* (one type). With sinuous wall and pitted cells and a single stoma, probably of grass (Fig. 3).

(*c*) *Spores* (six types). Two-winged spores with variable bodies and wings (two types), and pollen grains with (1) prominent exine, (2) germ pores, (3) two-ribbed elliptic body, and (4) in tetrad.

Further investigation is in progress, and a detailed note on the subject will be published later.

Our thanks are due to Dr. E. R. Gee, of the Geological Survey of Pakistan, who was kind enough to send us 'Salt Range' rocks from his personal collections for analysis.

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Sept. 22.

[1] Gee, E. R., *Curr. Sci.*, **2**, 460 (1934).
[2] Gee, E. R., *Proc. 27th Ind. Sci. Cong.*, Pt. 4, 10 (1940).
[3] Gee, E. R., *Rec. Geol. Surv. Ind.*, **81**, 144 (1943).
[4] Gee, E. R., *Proc. Nat. Acad. Sci. Ind.*, B, **14**, 269, 327 (1944); **16** (1945), in the press.
[5] Fox, C. S., *Nature*, **155**, 258 (1945); *Proc. Nat. Acad. Sci.*, B, **14**, 233 (1944).
[6] Sahni, B., *Nature*, **153**, 462 (1944).
[7] Sahni, B., *Proc. Nat. Acad. Sci. Ind.*, B, **14**, 49 (1944).
[8] Sahni, B., *Proc. Nat. Acad. Sci. Ind.*, B, **14**, i–xxxi (1944).
[9] Sahni, B., *Proc. Nat. Acad. Sci. Ind.*, B, **16** (1945), in the press.
[10] Sahni, B., and Trivedi, B. S., *Nature*, **154**, 54 (1944).
[11] Sahni, B., and Trivedi, B. S., *Nature*, **155**, 76 (1945).
[12] Bailey, E. B., *Nature*, **157**, 360 (1946).
[13] Coates, J., *et al.*, *Nature*, **155**, 266 (1945).

Number of Self-Sterility Alleles

In a note in *Nature* of September 6 [1], A. J. Bateman gives an interesting estimate of the number of *S*-alleles in a freely interbreeding population of self-incompatible plants, using the data of the late R. D. Williams[2]. In one sample of 25* plants, 36 alleles had occurred once only and 7 twice, while in a sample of 22 from a second variety, 38 had occurred once and 3 twice.

If a is the frequency of occurrence of any allele in a sample of N plants, we have for the two varieties

	$S\{a(a-1)\}$	$N(N-1)$
First variety	14	600
Second variety	6	462
Together	20	1062

Bateman, rightly in my opinion, calculates the ratio of the two columns, and finds in four times this ratio, or $n = 212{\cdot}4$, a reasonable estimate for the total number of alleles in each variety, when the evidence of the two samples is pooled, and if all alleles have the same frequency. The estimate by maximum likelihood is 197.

He adds, however, a 5 per cent upper fiducial limit of 442 alleles, expressing the opinion that the error in the calculation due to the variance in the frequencies of the different alleles is unlikely to be large compared with the sampling errors. I do not think, on these data, that such an upper limit can be given, although the lower limit is not open to this objection.

To take a simple model, if the frequencies of the different alleles were in geometric progression, with common ratio r, the expected value of $1/n$, as calculated above, would be

$$\frac{(1 - r^2)(1 + 2r^2)}{2(1 + r^2)(1 + r + r^2)},$$

even if the number of alleles were infinite. This gives an estimate for r between 0·990 and 0·991, so that the observed repetitions could be fully accounted for, even if the number of alleles were infinite (as in a finite population it cannot indeed be), provided the commonest alleles approach about 1 per cent in gene frequency.

R. A. FISHER

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University of Cambridge.
Oct. 14.

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* Williams did not fully investigate one of these plants (No. 17), but for the purpose of this letter I have accepted the data as used by Bateman.

[1] Bateman, A. J., *Nature*, 160, 337 (1947).

[2] Williams, R. D., *J. Genet.*, 48, 69 (1947).

Sclerotinia Porri on *Allium* spp. in England

WHILE working at Cambridge, Mrs. R. H. Richens found that plants of crow garlic, *Allium vineale*, examined in June and July, were often attacked by a species of *Botrytis*. Cultures of this fungus, made on Dox's agar in July 1946, have produced both *Botrytis* conidiophores and apothecia.

The conidiophores were short and the conidia measured 8–17 μ × 6–11 μ, averaging 11·7 μ × 8·6 μ. Mature ascospores were hyaline, markedly elliptical, normally with oil globules at both ends, and measured 11–25 μ × 6–11 μ, the average being 17·0 μ × 7·8 μ. The apothecia were large, up to more than 30 mm. in height and 12 mm. in disk diameter, and characterized by a dense mat of fine hairs over the lower portions of the stipes. The size of the apothecia varied with that of the sclerotia from which they grew, the largest being produced on large sclerotia, up to 15 mm. in length and 8 mm. in height.

In culture, the fungus produced abundant raised, fluffy, white mycelium. Conidial production was late and sparse, and a few small sclerotia were produced, also after some delay. In addition, many cultures produced one or two large, raised, irregular, 'convoluted' sclerotia. The mycelial felt was more pronounced and conidiophores almost absent in cultures on potato dextrose agar.

Single-ascospore cultures produced conidia, confirming the connexion between the *Botrytis* and the apothecia. Onions (*Allium cepa*) inoculated with the fungus developed a severe neck rot on which mycelial felt and sclerotia were predominant, conidia being few in number or absent. When inoculum which had been subcultured twice and carried in culture for three months was used, neck rot was not produced, indicating that the fungus may lose pathogenicity in culture.

Both the *Botrytis* and the apothecial stages of this fungus agree in their characters with *Sclerotinia Porri*, recorded on leek seed by van Beyma Thoe Kingma[1]. This is thought to be the first record of that species in England and on *Allium vineale*. It is interesting to note, however, that the *Botrytis* stage also agrees with the published data for *Botrytis byssoidea* Walker[2], which was recorded in England by Croxall and Pickford[3]. Walker states that this species loses pathogenicity in culture. It seems possible, therefore, that *Sclerotinia Porri* may be the perfect stage of *Botrytis byssoidea*, but further work will be necessary to determine this.

I am particularly indebted to Dr. W. A. R. Dillon Weston, who supervised this work, for much helpful advice and guidance. My thanks are also due to Dr. and Mrs. R. H. Richens for providing the diseased material, to Dr. A. Smith for suggesting that I should obtain it, to Dr. W. J. Dowson for advice and criticism, and to Prof. Johanna Westerdijk of Baarn for assistance in confirming the identity of the species. I also wish to acknowledge financial assistance from the Agricultural Research Council.

JAMES F. H. CRONSHEY

School of Agriculture,
Cambridge.
May 31.

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[1] Van Beyma Thoe Kingma, F. H., *Meded. Phytopath. Lab. 'Willie Commelin Scholten'*, Baarn (Holland), 10, 43 (1927).

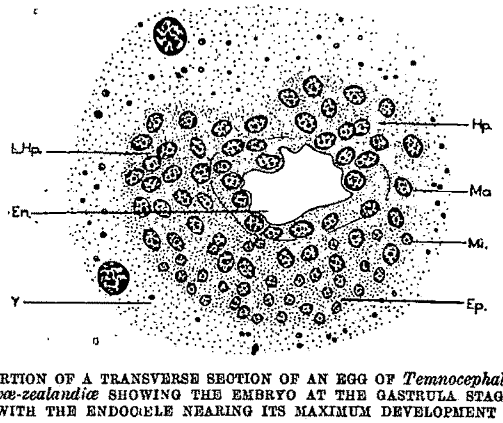
[2] Walker, J. C., *J. Agric. Res.*, 33, 893 (1926).

[3] Croxall, H. E., and Pickford, P. T. H., Rep. Agric. Hort. Res. Sta., Long Ashton, Bristol, for 1943, 57 (1944).

Embryology of *Temnocephala novæ-zealandiæ* Haswell

THE egg of *Temnocephala novæ-zealandiæ* consists of a zygote surrounded by polyhedral-shaped yolk cells. First cleavage results in the formation of a macromere and a micromere. The macromere divides into another macromere and a micromere, and after this three-celled stage each cell divides evenly and repeatedly, producing a large number of macromeres and micromeres. These constitute the blastoderm and are centrally situated in the yolk mass, which now is a syncytium (*Y*). When fully formed, the blastoderm is also syncytial in nature, thus necessitating the description of its component cells as macronuclei (*Ma*) and micronuclei (*Mi*). Two germinal layers are recognized. The macronuclei give rise to the œsophagus, intestine, reproductive organs and excretory apparatus and are regarded as belonging to the hypoblast (*Hp*). The micronuclei give rise to the nervous system, pharynx and body-wall and are regarded as epiblastic (*Ep*).

The gastrula stage is characterized by the formation of an endocœle (*En*). This cavity is presumably homologous with the archenteron, because it is the first cavity formed in the embryo of two germinal layers, it is hypoblastic, it afterwards forms the post-epiblastic portion of the alimentary canal and is persistent throughout the life of the animal.



PORTION OF A TRANSVERSE SECTION OF AN EGG OF *Temnocephala novæ-zealandiæ* SHOWING THE EMBRYO AT THE GASTRULA STAGE WITH THE ENDOCŒLE NEARING ITS MAXIMUM DEVELOPMENT

En, endocœle; *Ep*, epiblast; *Hp*, hypoblast; *L.Hp*, lateral hypoblastic band; *Ma*, macronucleus; *Mi*, micronucleus; *Y*, yolk syncytium

At its maximum development the endocœle extends for one third of the length of the egg, and at this stage organ-rudiments appear. Well-defined regions of hypoblast lie one on either side of the endocœle (*L.Hp*) and one on the ventral side. The epiblast partially segregates into a region anterior to the endocœle, another on its antero-ventral aspect and a third ventral to the ventral hypoblastic band. The three hypoblastic bands extend posteriorly to form the reproductive organs, while anteriorly they develop into excretory system rudiments. The ventral epiblastic band forms the body-wall by the migration of its cells through the yolk to the periphery of the egg. The anterior epiblastic region is the nervous system rudiment and the antero-ventral region is the pharyngeal rudiment.

The endocœle now undergoes marked reduction in size and the pharynx develops a large lumen. These two cavities unite and the endocœle thus becomes the œsophagus. Cells from the wall of the œsophagus proliferate and form an intestinal wall enclosing most of the remaining yolk material. At hatching, all internal organs have developed into a functional state except the reproductive systems.

A fuller account is being published elsewhere.

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Aug. 6.

Coiling of Wool Induced by Certain Reagents

DURING some investigations regarding twist in wool, some observations worth describing were made, though no explanation can be offered.

If a Merino wool fibre 4 in. long is anchored at each end and allowed to lie loosely in a horizontal position in a Petri dish in water, nothing obvious results. If the water is replaced with 1 per cent caustic soda (20° C.) several phenomena may be observed. Thus: (1) within 1 min. the original crimp disappears and the fibre appears 'lank'; (2) it goes into about three coils per inch within 3 min.; (3) it goes into fine turns within 8 min.; (4) it winds up more closely, averaging 15–20 turns per inch by 15 min., after which no further action is observed; (5) the direction of the coil reverses here and there along the length of the fibre.

No similar phenomena were observed in acid solutions.

If, after immersion for 15 min. in 1 per cent sodium hydroxide, the fibre is transferred to water or acid, the coils unwind; they reappear when the fibre is replaced in the sodium hydroxide solution. But if the period of immersion is two hours or more, the coils do not disappear in acid or water.

Human hair, produced in a relatively straight follicle, does not coil in a solution of 1 per cent sodium hydroxide; primary wool fibres, produced in relatively spiral follicles, go into large coils; secondary wool fibres, which come from coiled follicles, go into very close coils. No closer correlation has yet been made on this point. Wools of breeds other than the Merino behave similarly in all these respects but are less predictable as to behaviour.

It was found that under zero tension there was a 2–3 per cent decrease from the original length after immersion for 15 min. in 1 per cent caustic soda. If this were prevented for 24 hours by anchoring the fibre in the caustic soda at its original length, it will not assume fine coils when, afterwards, the ends are moved closer together, but it goes into a few irregular large coils.

Large irregular coils resulted from using the following solutions at 20° C.: 1 or 3 per cent potassium cyanide, 1 per cent sodium thioglycollate, and 0·125 and 0·33 per cent sodium sulphide and 0·88 S.G. ammonium hydroxide. 1 per cent potassium hydroxide gave results similar to 1 per cent sodium hydroxide, but barium hydroxide was not effective in this respect.

Merino wool in 1 per cent sodium sulphide (anhydrous salt) at 20° C. was then studied under similar conditions. In this solution the fibres immediately straighten out and remain straight for 1 min. They assume large coils within 3 min., and are very closely coiled in 6 min. (if transferred to water at this stage these coils disappear but reappear when again immersed in the sulphide solution), and 10 min. after immersion they again straighten. The fibres once more wind up into very fine coils 15 min. after immersion and may then disintegrate. The lengths of six Leicester fibres, which at no stage have been under tension, had increased finally in 1 per cent sodium sulphide between 33 and 56 per cent, averaging 47 per cent.

The action of 1 per cent caustic soda may be due to a high *p*H, and the further reactions of 1 per cent sodium sulphide may be due to subsequent reduction. Treatment of fibres with 1 per cent caustic soda for 15 min., followed by a wash in water which causes them to uncoil, and subsequent immersion in 1 per cent sodium sulphide resulted in the characteristic coiling, straightening and further coiling that has been described for 1 per cent sodium sulphide. Treatment of fibres with 1 per cent sodium sulphide until the *first* coiling has been completed (6 min.), followed by a wash in water and immersion in 1 per cent caustic soda, caused coiling similar to that previously permitted for these fibres in the 1 per cent sodium sulphide, but no subsequent straightening or further coiling as would be the case were sodium sulphide used finally instead of 1 per cent caustic soda. Treatment of fibres for 6 hours with 1 per cent caustic soda did not prevent them when afterwards immersed in 1 per cent sodium sulphide from straightening out and then coiling as described earlier. Such fibres, however, did not disintegrate and would bear weights of 0·1–0·2 gm. without undue stretching. This is in marked contrast to the eventual gelatinous nature of wool immersed in 1 per cent sodium sulphide without previous prolonged treatment with 1 per cent caustic soda. It is evident that the prolonged action of the 1 per cent caustic soda makes the wool resistant to the disintegrating action of 1 per cent sodium sulphide.

Obviously, further fundamental chemical, physical and histological studies must be completed before attempting to explain the phenomena described. The purpose of this note is to direct the attention of other workers to these facts so that they also may investigate what are indeed some very peculiar characteristics of wool.

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ANTITUBERCULAR ACTIVITY OF DIPHENYL ETHERS AND RELATED COMPOUNDS

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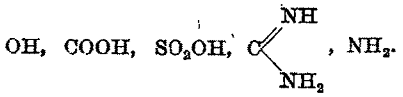
AND

D. TWOMEY

Department of Chemistry, University College, Dublin

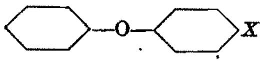
IN a previous communication in *Nature*[1], the inhibitory effect of soluble diploicin derivatives on the growth of the tubercle bacillus *in vitro* was described, and it was suggested that simpler diphenyl ether derivatives might also exhibit antitubercular properties. We have now prepared a variety of diphenyl ether derivatives as well as some related compounds in which the oxygen link has been replaced by $-O(CH_2)_n-$, $>CO$, etc. Several of these comparatively simple compounds are much more active than derivatives of diploicin. This activity against Mycobacteria is also shared by diphenylene oxide derivatives.

The first group of compounds examined by us were of the type I, where *X* represents a solubilizing group, for example,

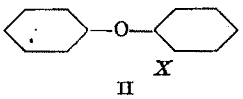


$$OH,\ COOH,\ SO_2OH,\ C\begin{matrix}\nearrow NH\\ \searrow NH_2\end{matrix},\ NH_2.$$

All the compounds of this type inhibit the growth of Mycobacteria in nutrient broth; but by far the most active were *p*-hydroxydiphenyl ether and *p*-aminodiphenyl ether (as the hydrochloride) which completely inhibits *Myco. smegmatis* at 1/100,000 and *Myco. tuberculosis* for six weeks at 1/35,000, while the *para* sulphonic or carboxylic acid derivative ($X = -SO_2OH$ or $-COOH$) showed no inhibition at 1/1,000. When the solubilizing group occupies the position *ortho* to the ether link, the activity is much reduced (II): thus 2-amino diphenyl ether (hydrochloride) completely inhibits the tubercle bacillus at 1/10,000.

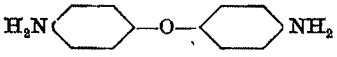


I



II

The substitution of two polar groupings in the *para* positions of diphenyl ether leads to molecules with low antitubercular activity.



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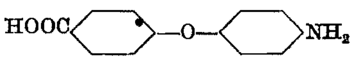
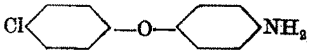


1/6,000

On the other hand, the introduction of a halogen atom into the second benzene nucleus in I or II produces compounds with considerably enhanced activity in I but not in II, as shown.



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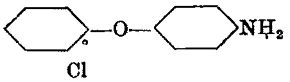

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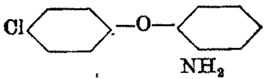

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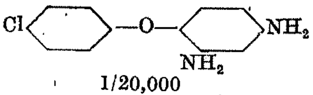
Halogen substitution will not, however, lead to active molecules if two amino-groups are present in one benzene nucleus. Two halogen atoms in the unsubstituted ring of I give a very active compound.



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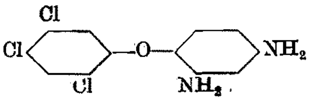

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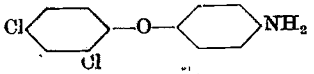
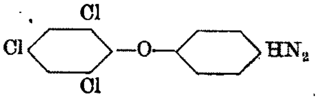


1/600,000

The effect of a further increase in the degree of halogenation on the antitubercular activity of these compounds is, at least at the moment, unpredictable. Thus the substitution of three halogen atoms in one benzene ring or divided between the two rings in I leads to strongly active molecules which may, however, differ considerably in activity.



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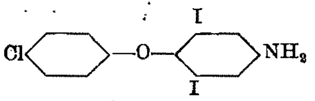

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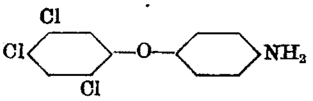

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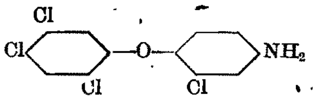
Again, a compound with four halogen substituents may show on the whole a comparable activity.



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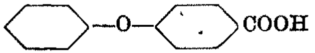
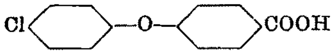
While it is not safe at this stage to make any final deductions relating structure and antitubercular activity in these highly halogenated compounds, it is noteworthy that a more symmetrical disposition of halogens may not occur in the molecules possessing greater inhibitory activity.

The enhancement of biological activity consequent on the introduction of halogen atoms is not confined to amino-diphenyl ethers but occurs also with other derivatives.



inactive at 1/1,000



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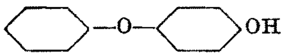
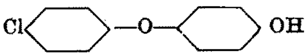


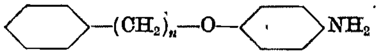
1/100,000



1/300,000

Replacement of the amino- by the amidino-group in I weakens the antibacterial activity. Chlorinated derivatives of amidino-diphenyl ether are at present being examined. These compounds were kindly placed at our disposal by Dr. A. J. Ewins, director of research to May and Baker, Ltd. The effect of substituting other groups in I and II has been examined to a limited extent but will not be dealt with here. Walter has examined[2] a large number of hydroxydiphenyl ethers for antibacterial properties. The test organisms employed in his case were *Staphylococcus aureus* and *Bact. coli*, and none of his compounds contained aromatic amino-groups. In his derivatives, the oxygen link could be replaced by S, Se, NH or CH$_2$ while still retaining the same order of biological activity. We have not yet tested adequately similar modifications of our molecules.

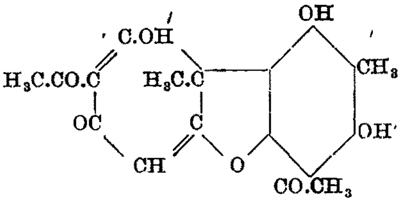
It is of interest that compounds of the type shown in III also display considerable antitubercular activity.



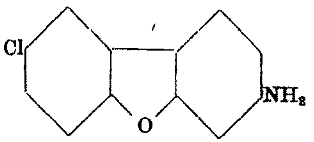
III

The compound derived from phenylethyl alcohol ($n = 2$) has an inhibitory dilution of 1/150,000. This compound is of peculiar interest, as Goris and Sabetay have recently reported[3] the isolation of phenyl ethyl alcohol from tubercle bacilli and have attributed the characteristic odour of the bacilli, at least in part, to the presence of this substance. The effect of introducing halogen atoms into the benzene nuclei in this series has not yet been tested.

Antitubercular activity extends also to simple derivatives of diphenylene oxide (IV). Marshak has recently described[4] the isolation of a yellow crystalline substance from the lichen *Ramalina reticulata*. He has shown that this substance inhibits the growth *in vitro* of *Myco. tuberculosis* and exercises a suppressive effect on tuberculous infection in guinea pigs. While Marshak calls this substance 'Ramalina crystals', the analyses and properties of the substance as given by him correspond closely with what would be expected for *usnic acid*. (These views have been communicated privately to Dr. Marshak, who has confirmed the identity of his material with usnic acid[5].) It has been shown in this laboratory that usnic acid does inhibit strongly the growth of *Myco. tuberculosis in vitro* and that it retains to a considerable extent this activity in the presence of 5 per cent human serum. From the structure shown, which was suggested tentatively by Curd and Robertson[6], it will be seen that usnic acid has the skeleton structure of a diphenylene oxide derivative. This fits in remarkably with our experience of compounds of this type. 2-Amino-diphenylene oxide in the form of its hydrochloride inhibits the growth of the tubercle bacillus at 1/100,000, while its monochlorinated (or brominated) derivative (IV) causes complete inhibition at 1/400,000 and partial inhibition at 1/1,000,000. The position of the halogen atom in IV has been established[7].



Usnic acid
1/500,000



IV
1/400,000

This account gives some idea of the remarkable antitubercular activity exercised *in vitro* by these relatively simple compounds. It will not be possible, however, to draw final conclusions as to the relationship existing, in these related series, between constitution and anti-tubercular activity until a very great number of compounds has been prepared and examined.

This investigation is being conducted under the auspices of the Medical Research Council of Ireland, and the biological tests were carried out by Dr. P. A. McNally, Trinity College, Dublin, to whom grateful acknowledgment is made.

[1] Barry, *Nature*, **158**, 131 (1946).

[2] Walter, "Festschrift Emil C. Barrell", Basel, 266–283 (1936).

[3] Goris and Sabetay, *C.R. Acad. Sci., Paris*, **223**, 933 (1946).

[4] Marshak, U.S. Public Health Reports, **62**, 3 (1947).

[5] *Note added in proof.* In a recent paper by Stoll, Brack and Renz (*Experientia*, **3** (3), 115; (1947)), similar results are recorded with usnic acid.

[6] Curd and Robertson, *J. Chem. Soc.*, 898 (1937).

[7] Cullinane and Padfield, *J. Chem. Soc.*, 1131 (1935).

APPLICATION OF FILTER PAPER PARTITION CHROMATOGRAPHY TO RADIOACTIVE TRACER STUDIES

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AND
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THE filter paper chromatographic procedure developed by Consden, Gordon and Martin[1] has proved to be very useful in the qualitative and semi-quantitative analysis of amino-acid mixtures, and appears to have possibilities for extension to a variety of other compounds[2,3].

* Rockefeller Fellow on leave of absence from University College Hospital, London.

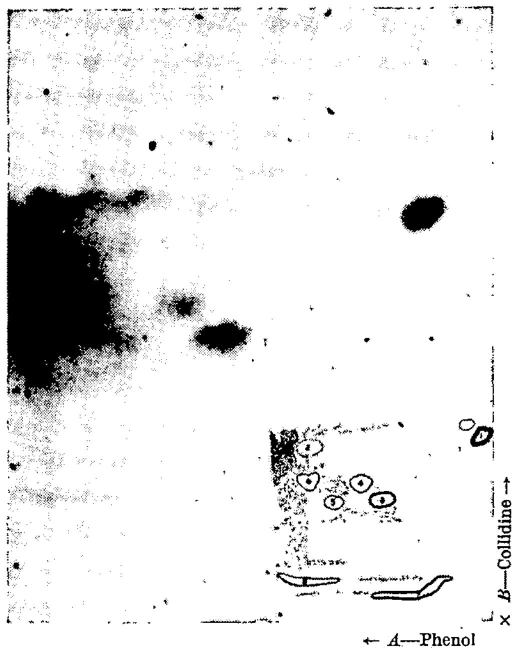

Fig. 1

It was believed that the technique would also be useful if it could be applied to the study of the metabolic fate of compounds labelled with radioactive isotopes. Radio-iodine (I^{131}, half-life 8·0 days) was immediately available and seemed a reasonable choice of isotope for testing the feasibility of using paper chromatography in conjunction with radio-autography, since it gives off a moderately penetrating beta ray (0·6 Mev.), and a reasonably large proportion of the dose can be recovered in the small amount of tissue hydrolysate that has to be used in order to avoid overloading a paper chromatogram. A preliminary test in which carrier-free radio-iodide alone was run through the chromatographic-radio-autographic procedure indicated that even extremely minute amounts of material could be handled successfully by paper chromatography.

In order to test the procedure in a biological experiment, 250 microcuries of carrier-free I^{131} was administered intravenously to each of two normal adult rats. After 24–48 hours the rats were killed and the thyroids removed and hydrolysed with barium hydroxide in the manner usually employed in the determination of di-iodotyrosine and thyroxine. An aliquot of the neutral hydrolysate containing about 50 μgm. of total nitrogen was taken and run on a phenol/collidine two-dimensional paper chromatogram. A duplicate with added di-iodotyrosine, thyroxine and potassium iodide was treated similarly. A further chromatogram was run with only I^{131} present, as a control on the possible formation of iodinated compounds with the solvents. Similar runs were made on the one-dimensional paper strips, using various solvents. From each of the papers a radio-autograph was finally taken by placing the chromatogram, with only a sheet of 'Cellophane' intervening, against an X-ray film for up to seven days. The substances containing radio-iodine showed their presence on exposing the adjacent area of film. The papers were finally developed to show up the amino-acids and iodides. Ninhydrin was used for the former, and silver nitrate, followed by washing and exposure to light, for the latter. The added di-iodotyrosine and thyroxine could be readily picked out on the basis of their positions as determined from chromatograms of the pure compounds alone. It was an easy matter to determine, by superposition of the X-ray film on the developed chromatograms, the correspondence or otherwise between the spots on the film and those on the paper. Examples of the radio-autographs are shown in Figs. 1 and 2.

Fig. 1 is a radio-autograph of the two-dimensional chromatogram of hydrolysate of rat thyroid gland 48 hours after a tracer dose of I^{131}. The material was placed at the lower right corner. Phenol was first run from right to left and then collidine in an upward direction. The strong spot, marked 1 on the accompanying tracing, corresponded to the position of the bulk of the inorganic iodide; the weaker spot slightly above and to the left of it is usually seen and has not been identified. The thyroxine added to the hydrolysate as a marker went to the region of low radioactivity marked by the number 2, indicating that little, if any, radio-iodine was present in the thyroxine 48 hours after the iodine injection. The diffuse dark region to the left and above this is probably a solvent artefact, as it is also found when radio-iodide is run alone on the chromatograms. It corresponds also to the region where a visible yellow colour is formed from oxidation of the phenol used as the first solvent. The dark spot No. 3 corresponds exactly with di-iodotyrosine. Nos. 4, 5 and 6 are unknown I^{131}-containing substances. The two streaks, 7 and 8, have been constantly seen so far. It is difficult to understand what has produced them. They occur in the midst of the known amino-acids of the hydrolysate. All the well-defined radioactive spots are well clear of the positions of the common amino-acids. The rat killed after 24 hours gave similar results.

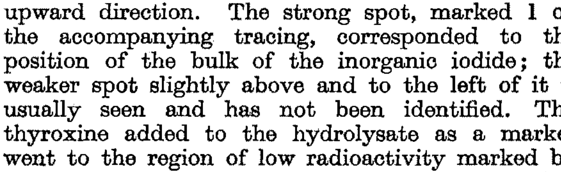

Fig. 2

Fig. 2 is a radio-autograph of two one-dimensional chromatograms. The upper one was run with phenol and the lower with collidine. The pinholes at the left indicate the starting point and those at the right the extent of the boundary travel. In each strip, 1 corresponds to the position of inorganic iodide, 2 to thyroxine, and 3 to di-iodotyrosine. It is seen that in collidine the thyroxine and the iodide run to the same position. The other bands are due to unknown substances.

The radio-autographs therefore indicate definite spots of radioactivity at the positions taken by inorganic iodide and di-iodotyrosine, little, if any, radioactivity at the spot corresponding to thyroxine, a diffuse background of radioactivity in one corner similar to that obtained from a chromatogram of a sample of the I^{131} injection solution alone, and several spots of radioactivity from unidentified substances. These unidentified spots have appeared consistently and in similar relative strengths in six two-dimensional chromatograms from the thyroid glands of the two rats. There can thus be little doubt that they represent chemical individuals, though whether they were originally present in the thyroid or were formed during subsequent treatment of the tissue has yet to be determined with certainty.

In any event the results obtained in this first experiment make it appear likely that with further improvements in technique a valuable new tool for the study of intermediary metabolism will be established. The final elucidation of the possible significance of these data with respect to thyroid physiology will probably require more work than we are in a position to undertake in the immediate future. It is for this reason, and with the hope that the technique may be of value to other investigators, that the results are being reported in the present incomplete form.

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[1] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, 38, 224 (1944).

[2] Dent, C. E., *Biochem. J.*, 41, 240 (1947).

[3] Partridge, S. M., *Nature*, 158, 270 (1946).

BRITISH SOCIAL HYGIENE COUNCIL

INTERNATIONAL SCHOOL IN SOCIAL BIOLOGY

THIS year the British Social Hygiene Council held its first international school in social biology at Berne, Switzerland, during August 21–September 4. The school was attended largely by teachers and welfare-workers, most of whom came from Great Britain, although a few from other nations gave enhanced interest to the proceedings. It was planned to be a blend of work and pleasure, the first week being devoted to regular lecture-sessions, and the second to excursions and personal recreation. The members were housed in groups in various hotels in Berne, while all meetings were held in the University buildings, where lecture-room accommodation had been placed at the Council's disposal free of cost.

The lectures and discussions were held in English. For the ordinary morning sessions the Council took out a staff from England; during the evenings the School had the privilege of hearing addresses by Swiss men of science and social workers. Prof. P. B. Medawar gave a series of lectures concerned with the principles of pure biology. In succession, he spoke on "Growth", "The Theory of Evolution from a Modern Standpoint", "Ageing in Individuals", and "Adaptation and Directive Behaviour". He was at pains to emphasize the comparative aspects of organic development, which he interpreted on modern genetical lines. Everyday problems of psychology at different stages in life were presented in four lectures by Dr. Mary Smith. Her subject-matter formed an integrated whole which served to give those who had had little previous experience of psychology a clearer understanding of its scope and method as well as insight into individual problems of their own.

Reflecting more directly the particular outlook of the British Social Hygiene Council, Mr. R. Weatherall spoke on "The Creative Mission of Social Biology", "The Human Family in a Changing Environment", "Some Implications of Modern Concepts of Race", and "The Human Aspects of Evolution". In choosing these subjects for his lectures his intention was to direct interest to broad problems of public concern in which social biology finds important applications which cannot be ignored. Further individual lectures were given by Miss M. M. West on "The Public Health Nurse and the Family Unit", and by Miss J. E. R. Kennedy on "The Police Court and the Community". Two informal Sunday meetings on the relationships between social biology and spiritual values led to a useful exchange of views, but served to show that on such a wide subject and without outside direction the method of open discussion does not take one very far.

Among the visiting speakers, the British Social Hygiene Council owes a special debt of gratitude to Dr. H. Revilliod for his invaluable help and advice. In his address on "Some Ways of Facing Social Evils in Switzerland" he explained how through careful organisation his country had been shielded from serious epidemics of infectious disease throughout all the disturbances of the war-time years. He referred to very satisfactory results now being obtained in the treatment of tuberculosis, and to the advantages of occupying the patients with gainful work. He also referred to the change in public attitude towards drunkenness in Switzerland, where even in the penal code it is recognized that heavy drinkers are sick members of society and in need of special care. His lecture ended with a description of the great success which has been attained in the prevention of endemic goitre by the addition of small amounts of potassium iodide to household salt. In earlier times the disease was very widespread in certain areas, giving rise to many cretinous and backward children, a number of whom were mute and deaf; now among young children it has disappeared.

Dr. St. Zurukzoglu contributed a paper on "Social Psycho-Hygiene". It was interesting to find that quite independently and through his own work he has arrived at a conception of social biology similar to that of the British Social Hygiene Council. In his view, organic factors, heredity, environmental influences and psychological dispositions were all contributory agents in the causation of disease. To cure the spiritually sick seemed to him as important as to heal the physically unwell, and he called for a medical pastoral service to work alongside that based on religion.

Dr. E. R. Frey of the Staatsanwalt gave a particularly stimulating address on "Biology and Juvenile Delinquency". Basing his argument on the theme that the treatment of juvenile delinquency is the foundation for all prevention of crime, he made it clear that only about 25 per cent of young offenders grow up into confirmed criminals. Members of this special group show serious abnormalities of a psychological nature and are often of low mental ability at the same time. As predisposing influences in the causation of crime, constitutional factors seem much more important than environmental conditions. The conclusion to which Dr. Frey's thesis led was that the treatment of young offenders should be based upon their biological circumstances and not upon the nature of their deed.

During the School, and in addition to excursions to some of the scenic attractions of Switzerland, visits were paid to certain departments of the hospital quarter at Berne, *Kindergarten* and other educational institutions, a housing estate, the international Pestalozzi school for refugee children at Trogen, the cantonal agricultural school at Rüti, and La Nuchtern, a home for the treatment of drunkards. Through the kind offices of Dr. V. J. Steiger, members of the

School were also able to see two films, the first dealing with the problem and treatment of drunkenness in Switzerland, and the second with the utilization of fruit, either in a fresh or preserved state, for human consumption or as a source of unfermented juices which can be made into most attractive drinks the popularity of which is increasing year by year.

R. WEATHERALL

CO-OPERATION IN BOTANICAL RESEARCH

FOR his presidential address to the Botanical Society of America (December 28, 1946), Dr. I. W. Bailey, chairman of the Institute for Research in Plant Morphology at Harvard University, selected the theme of "Co-operation Versus Isolation in Botanical Research" (*Chronica Botanica*, **11**, 1947).

In a world subject to profound and drastic changes, Dr. Bailey considers it inevitable that botanical science must also be affected, particularly the older branches of the subject. To quote his own words, he raises "the challenging question, what roles should taxonomy, anatomy, palæobotany and other phases of morphology be expected to play in future developments ?". A whole book could be devoted to the answer. Certainly the way has been prepared for a brisk and lively discussion.

"There are, of course, two extreme views regarding the matter. On the one hand, there are individuals who believe that these largely descriptive disciplines are moribund, if not actually over-ripe for interment, and that funds now dissipated for their support should be diverted into productive ultra-modern, experimental channels. On the other hand, there are those laissez-faire individuals who naively assume that civilization must continue to support their endeavours regardless of how unproductive their viewpoints and methodologies may have become.

"The latter individuals are living in a dream world of their own creation which is destined sooner or later to be rudely shattered. The former individuals fail to visualize the extreme complexity and variability of biological phenomena, and thus overlook or ignore numerous significant morphological variables in their experimental material."

In the first place, he asks if the extensive morphological researches of the last hundred years have not provided sufficient data to serve the purposes of contemporary and future experimental disciplines, in particular, those of the physiologist, the biochemist and the biophysicist. When these workers turn to the standard texts, can they find in them the information which they require ? Dr. Bailey replies in the negative, and in this he will be supported by most botanists who have given thought to the matter. Many of the supposedly fundamental ideas of plant anatomy are inadequate, based as they were on researches undertaken in relation to phylogenetic questions. An impartial consideration of almost any of the major problems of contemporary interest will reveal how much scope still remains for morphological inquiry. To quote Dr. Bailey : "It is evident that significant progress in the solution of important botanical problems is being retarded by inadequacies of existing morphological data and by the unquestioning acceptance of unreliable generalizations". He then asks how these difficulties are to be avoided in the future, and emphasizes the dangers and drawbacks of premature specialization in instruction and research. "This encystment of botany in specialized subdivisions encourages premature and excessive generalizations from limited induction and tends to inhibit unified attacks along broad fronts, such as are essential for the solution of the more complex and difficult types of botanical problems." The solution of any of the major problems of biology requires the close co-operation of workers in different fields and a harmonizing of the data of the several contributory disciplines. Various means are available whereby co-operation can be encouraged, but as to how the latter aim is to be achieved Dr. Bailey is rather less specific. The magnitude of the task is oppressive : in practice it will call for the sustained activities of a team of workers. Yet, as experience teaches, major biological syntheses depend on the special qualities and capacities of particular individuals, and these, apparently, are of rare and sporadic occurrence.

Morphologists, whether adherents of old or new conceptions, are not alone in being scourged by Dr. Bailey. "If one probes deeply into the applications of physics and chemistry in the analysis of plant materials one likewise finds evidences of premature and excessive generalization from restricted viewpoints. I have encountered this tendency in exaggerated form in chemical analysis of plant tissues and particularly in physical and chemical investigations of the walls of plant cells. The specialist in specific physical and chemical methodologies is likely to run astray unless his deductions are verified by individuals who are thoroughly familiar with the full complex of structural variables in a wide range of plants."

But Dr. Bailey is by no means pessimistic in his outlook for plant morphology. He views with confidence a future in which taxonomy, anatomy and other morphological disciplines will be stimulated and broadened by close contact with one another and with other branches of the science. The result should be a closer approach to the solution of the central problems of biology. "To facilitate such mutually beneficial relationships, it is essential to break down existing emotional and intellectual barriers." The morphologist must recognize the limitations of his own techniques and appreciate the assistance which other disciplines can afford him in solving problems in his own particular field. "He must acquire sufficient familiarity with chemistry and physics to enable him to talk intelligently with workers in other disciplines." In emphasizing this point, Dr. Bailey's observations are no doubt pertinent in relation to some of the research institutions in the United States : in a majority of British universities, a reasonable knowledge of chemistry and physics is now regarded as an essential preparation for botanical studies.

A particular interest is attached to that section of the address in which Dr. Bailey attempts to show how co-operation between the different subdivisions of botany is to be achieved. "It cannot be coerced or developed directly by administrative fiat. It must arise naturally and more or less spontaneously or not at all. The wisest and most effective procedure should be to create a general environment that encourages rather than inhibits co-operative efforts." To some extent this can be achieved by wise administration, particularly by making suitable appointments and the judicious allocation of funds. An allocation of funds which tends to encourage excessive diversification and specialization and which favours "unbridled individualism" is to be deplored. "Such policies may yield spectacular and highly significant results during the pioneering stages of a new trend of specialization, but frequently leave a large residue of injurious consequences, and do not create a general environment favourable for co-operative endeavours. I do not imply by this that one should make a fetish of team-play or that the lone wolf and the prima donna should be eliminated and replaced by amiable mediocrities, but rather that the training of graduate students should be broadened and that where individuals of recognized ability wish to co-operate in research, funds to encourage such relationships should be available. . . . We must now strive in botany as in national affairs to prevent a reversion to isolation and to intellectual encystment."

Even in the larger universities in the United States it is not anticipated that extensive schools of research in all the subdivisions of botany can be supported. Dr. Bailey advocates that each university department should develop strength in particular directions and that students should be free to move from one university or institution to another according to their special interests.

In concluding, Dr. Bailey considers how the funds available for botanical research can best be used. One of the methods commonly adopted is to give handsome support to one or two leading individuals who have established a reputation in a particular field. This he regards as possibly the easiest and least expensive way for some institutions; it may even be the easiest and least expensive way of advancing the frontiers of science. But other possibilities should not be overlooked. Policies of the kind mentioned above commonly lead to narrow specialization and they "tend to inhibit attacks upon major biological problems which require the concatenated efforts of different disciplines for their solution". In their more exaggerated forms, they may in time create such a complex of competitive subdivisions as to render impossible the integration of the data of the several branches. Botanical science must inevitably suffer from the attendant disruption.

C. W. WARDLAW

FORMULÆ AND BRAIN WEIGHTS

PROF. E. W. COUNT[1] has recently examined the various formulæ which have been suggested for expressing the relationship between brain-weight and body-weight in vertebrates, and has also introduced a new formula. In his extensive study he states that his objects are: "(1) to formulate the growth behaviour between brain and body weights in human ontogeny, (2) to find any traits in common with other Primates and Mammalia, (3) to formulate analogous behaviour in comparative anatomy; and (4) to search for any connexions between ontogeny and comparative anatomy". His paper is divided into five sections: (1) is introductory, discussing method and terminology; (2) deals with the data and formulæ from the point of view of ontogeny; (3) discusses the comparative anatomy problem, includes an extensive criticism of previous work and introduces the author's new formula; (4) attempts to relate the ontogenetic results to the phylogenetic; and (5) is a summary. The paper concludes with an extensive bibliography and a number of tables of data.

If we denote brain-weight by y, body-weight by x, and parameters by a, b, c, Prof. Count's main conclusions appear to be as follows:

(*a*) Ontogenetically, in both fœtal and post-infantile stages, the relationship $y = ax^b$ will hold.

(*b*) Phylogenetically, for mammals the relationship is, $y \doteq ae^{bx-cx^2}$; for reptiles $y = ae^{bx+cx^2}$. The form $\log y = \log a + b \log x \pm c (\log x)^2$ is termed the 'cephalization function'.

(*c*) If the intersection of the reptilian cephalization exponent with the general mammalian exponent is taken as a new origin, then the mammalian exponent may be considered as a transformation of the reptilian.

(*d*) Increase in absolute body-size is requisite for higher cephalization. This latter term is nowhere clearly defined, but appears to be related to some concept of more complicated structure and function.

Prof. Count's discussion of the data and their sources is full and most welcome; he not only supplies the reader with lists of some of the available data, but also includes tables in which these data are collected. Unfortunately, many of these figures are mean-values and consequently of considerably less value than the individual observations. For some reason Dr. H. B. Latimer's excellent data on cats are not included, and are considered to be "*too* good"; no reason for such a rejection is given.

Snell[2] was first to suggest the use of the formula $y = ax^b$, and the adoption and development of this formula for brain/body weights by Dubois, Lapicque and Brummelkamp is well known. These authors have maintained that the value of the parameter b is $0{\cdot}56$ for different but related species of vertebrates, but is $0{\cdot}26$ for animals of different sizes but belonging to the same species. Brummelkamp, moreover, has stated that the values of $\log a$ are always integral multiples of $\sqrt{2}$. Count discusses this work in considerable detail and rightly concludes that these suggested values for the parameters have no adequate foundation. This work has already been criticized by v. Bonin, who has treated the data from a different point of view and fits a straight line to the logarithms of the body-weights and brain-weights of mammals, concluding that the value of b was $0{\cdot}655$ while the value of a varies from species to species. Count's objection to v. Bonin's treatment seems to be mainly subjective; he thinks that mammals form too large a group, and considers that if two animals have the same body-weight, the one with the larger brain will be the more intelligent. The method of v. Bonin does not lead to this conclusion.

Many of these criticisms are well founded, especially those directed against the Dubois–Lapicque–Brummelkamp school, but other equally radical criticisms may be made which would also apply to Count's own treatment—the mathematical treatment is quite inadequate.

If it is decided to fit a curve $y = f(x, a, b, c \ldots)$, where x is the independent variable and a, b, c are parameters, it is necessary to make certain assumptions about the distribution of the variables. If we fit by the method of least squares, we usually assume that the x's are free from error and the y's are normally distributed; the values of the parameters and their standard errors can then often be estimated. The authors discussed by Count, and Count himself, assume that the results of fitting

$$y = ax^b \text{ and } \log y = \log a + b \log x$$

will be the same. This is not the case, since we assume y to be normally distributed with x free from error in the first case, whereas in the second case log y is assumed to be normally distributed with log x free from error. If y is normally distributed, the distribution of log y will not be normal, and conversely. This point has been briefly discussed elsewhere[3]. Presumably, Count has assumed a log normal distribution, but he has not estimated the standard errors of the parameters and consequently comparisons between their values are impossible. Furthermore, his curves have been fitted to mean values of groups; this leads to further difficulties which are not mentioned, and it would appear that mean values have been treated as if they were actually observations.

It is not clear why the particular form $\log y = \log a + b \log x - c (\log x)^2$ should have been chosen as giving the best description of the data. A number of formulæ is listed (p. 1,034), and the author states that these are "less satisfactory". No indication of a criterion for this judgment is given, but it would appear that it was merely subjective ("It seems a very fair fit", p. 1,042). In fact, although the author prefers his formula to the allometric form, he nowhere shows that his formula does, in fact, give a closer fit: since he introduces an extra parameter, it probably does.

Count also criticizes previous workers for allowing their personal views to influence their choice of data, but he does not appear to be free from this reproach himself; for example, he omits the Cynocephali from the Cercopithecidæ "because of their obviously high specialization" (p. 1,035). His omission of Dr. Latimer's data has been noted already.

No theoretical justification is given for the new formula and no biological interpretation of the parameters is suggested. If it were possible to find a theoretical basis for this formula, one would find it of greater interest; but the author says that it is frankly empirical and offers no hope of any such justification. The analogy which is drawn between the cephalization exponent and the path of a projectile is quite unconvincing.

The paper is not easy to read. The author speaks of "complex exponents in place of the b": presumably he means that b may be a real function of x and not merely a number. The adjective 'statistical' is used where the author seems to mean 'numerical'. The sentence (p. 1,055) "This apparent fact may be important, evolutionally: for good results in geometric statistics, it is vitiating" is incomprehensible. Many other examples could be quoted.

Prof. Count has provided a valuable summary of the data relating to his subject, and his criticisms and speculations are interesting. Unfortunately, he has failed to apply modern statistical methods and to appreciate the limited value of empirical formulæ. Any such formulæ would imply that the increasing complexity of the brain, both in structure and function, which is found in vertebrate phylogeny, can be analysed in terms of its weight and that of the body of the animal. It is doubtful if this is possible since, although the physiological unit of neural activity may be the same throughout the vertebrate system, it would appear that the anatomical patterns formed by these units increase in complexity and not merely in size. For example, the optic tecta of Amphibia and Reptilia have different structural patterns, and the thalamus of Reptilia has a different pattern from that of rodents and so on. Even for these two structures the analysis must go deeper; *a fortiori* it would seem that mere weight is far too superficial a unit for the analysis of the total brain.

In order to make a mathematical analysis of brain organisation, either in ontogeny or phylogeny, the physiological patterns and their correlated anatomical structures need deeper quantitative investigation. It may then be possible to form a mathematical model which will enable us not only to picture our present knowledge concisely, but also will suggest directions for future research.

DONALD SHOLL

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[1] Count, E. W., "Brain and Body Weight in Man: Their Antecedents in Growth and Evolution. A Study in Dynamic Somatometry", *Ann. New York Acad. Sci.*, **46**, Art. 10, 993–1122 (1947).

[2] Snell, O., *Arch. f. Psychiat. u. Nerv.*, **23** (2) (1891).

[3] Sholl, D., *Nature*, **159**, 269 (1947).

RUTHERFORD CELEBRATIONS IN PARIS

ON November 7 and 8, in Paris, the World Federation of Scientific Workers, the president of which is Prof. F. Joliot-Curie, held a solemn commemoration of the tenth anniversary of the death of Lord Rutherford. This graceful and extremely successful tribute by scientific men from all parts of the world emphasized the international character of science and the deep regard and lively admiration of men from twenty nations for the work and personal qualities of the greatest of contemporary British scientists. The presence of Lady Rutherford, and of two of her grandchildren, gave a personal character to the ceremony which a purely scientific gathering would have lacked.

The conference proper began with a reception by the President of the French Republic in the afternoon of November 7 at the Élysée Palace, at which guests were received by the President and Mme. Auriol. The Premier and members of the Cabinet were present. M. Auriol spoke of the work of Rutherford and of the international character of science, and expressed optimism that the fruits of his genius and of science in general would be used for the good of mankind. Prof. F. Joliot-Curie responded. The grandeur of the Palace, the magnificence of this tribute by the French nation through its President, and the charm of our hosts, made a deep impression upon all, and especially upon the British delegates.

In the evening at 9 p.m. a solemn commemoration was held in the Great Hall of the Sorbonne. The French Foreign Minister, M. Bidault, was in the chair and the hall was crowded with more than two thousand people, including diplomatic representatives of many countries. Tributes were paid by Prof. Niels Bohr (Denmark), whose message was read by Dr. Møller, by M. de Broglie (France), Prof. M. L. Oliphant (Great Britain), Prof. Harold Urey (United States), and Prof. Joliot-Curie (president of the World Federation of Scientific Workers). A large illuminated photograph of Rutherford hung over the stage, an orchestra played before the proceedings began and between the speeches, and the recorded voice of Rutherford was heard through the loud-speaker system. This was a most solemn and moving occasion.

On the morning of November 8 further tributes were paid in the lecture theatre of the Collège de France by Prof. M. N. Saha (India), Sir George Thomson (Great Britain), Prof. J. S. Foster (Canada) and Mme. Irène Joliot-Curie (France). M. Louis de Broglie was in the chair. It is understood that all speeches will be published in French. Advantage was taken of the character of the gathering to hold a discussion on the international and social implications of modern science, a subject dominated at the present time by atomic energy, the practical fruit of the scientific labours of Rutherford and his colleagues throughout the world.

There was a reception at the Maison de la Pensée Française and a lecture on "The Function of International Science in the Solution of the Economic Problems of To-day" delivered in French by Prof. J. D. Bernal.

It was particularly fitting that these celebrations should have been held in France, where Becquerel and the Curies laid the foundation of nuclear physics by their pioneering discoveries in radioactivity, and especially that the daughter and son-in-law of the Curies should have been largely responsible for the conception and organisation of the conference. Those of us who were students and colleagues of Rutherford found the proceedings in every way appropriate, magnificent in conception and strangely moving. This spontaneous tribute to the genius and lovable personality of Rutherford merits the gratitude of all Britons.

The organisation of the commemoration was in the hands of a committee of the World Federation of Scientific Workers, and its great success was due largely to the generous hospitality of the French Government and its full participation in the proceedings. The United Nations Educational, Scientific and Cultural Organisation recognized the unique significance of the occasion by providing funds to cover the travelling expenses of many who attended.

M. L. Oliphant

CULTIVATION OF THE CRICKET BAT WILLOW

In Forestry Commission Bulletin No. 17 (London: H.M. Stationery Office, 1946) the cultivation of the cricket bat willow is described. The tree willows are divided into two groups. In the first, the trees are pollarded and yield small produce such as stakes and poles, the latter used for hurdles and rough fencing. In the second group, timber of larger size is produced which may be used, as in some parts of the Midlands, for making field gates, but of which the best known and most important manufactured product is the cricket bat. Pollarded willows are very characteristic sights in many parts of England as, for example, in the valley of the Thames; Somersetshire marshes; the levels of the Bedfordshire Ouse, and along many of the small streams in southern England. In most cases the agricultural population know well how to deal with this type of tree, the numbers of which do not appear to diminish in the parts of the country where they are found, and their produce furnishes a very useful source of certain types of woody material in use by the agricultural community.

When the object is to produce material of timber size, the areas devoted to willow must be treated on a more intensive forestry method, and this applies to a very high degree in the case of trees from which it is desired to obtain timber for the manufacture of cricket bats. With this object in view the willow must be selected with very great care so far as the willow stock is concerned, and to-day, for the purpose in question, it has led to an ever-increasing demand for *Salix alba* var. *cærulea*. The demand for this variety has been a matter of gradual development, and the methods of its cultivation have been carefully improved, based on trial and error with reference to methods of propagation and planting.

In the past, a number of private owners have tried to undertake the production of this high-quality willow timber, with the object of selling it as material for cricket bat production, and considerable failures have resulted. It is not that the cultivation of the willow itself is actually difficult, but a great deal of close attention is necessary, and more especially during its early life, and the right variety must be obtained at the start. It is for this reason that the Forestry Commission has had drawn up and issued this bulletin on the cultivation of this valuable product. The subject is dealt with under situation, climate, soils, propagation (by various methods), planting and tending the trees; also the various types of possible damage are discussed; the character and uses of willow timber, and finally the systematy of the cricket bat willow and its allies. In fact, the bulletin may be considered to be an up-to-date guide to any who wish to take up this interesting branch of economic tree-growing. There is also a number of plates illustrating the text.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, December 6

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. Donald Hindson, Jr.: "Some Aspects of Dutch Coal Mining".

Monday, December 8

Chemical Society (in the Main Chemistry Lecture Theatre, The University, Edgbaston, Birmingham), at 4.30 p.m.—Dr. W. A. Waters: "Mechanisms of Oxidation".

Institution of the Rubber Industry, Midland Section (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 7.15 p.m.—Dr. D. Parkinson: "Newer Developments in Carbon Black".

Tuesday, December 9

Zoological Society of London (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. N. H. Pratt: "The Heat Transfer in a Reaction Tank Cooled by Means of a Coil".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. B. E. G. Mittell: "Commercial Disc Recording and Processing".

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. J. H. Nelson: "Decoration and Industrial Lighting".

Royal Institute of Chemistry, London and South-Eastern Counties Section (in the Material Research Laboratory, Philips Lamps, Ltd., New Road, Mitcham Junction), at 7.15 p.m.—Mr. C. G. A. Hill, assisted by colleagues: "Luminescent Materials—their Properties and Uses", with demonstrations.

Wednesday, December 10

Institute of Fuel, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. S. W. Bertenshaw: "Oil Firing Practice".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Michael Graham: "Science and the Fishing Industry".

Geological Society (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. Hurworth: "Some Observations on Oil Deterioration in Transformers and Switchgear"; Mr. J. S. Forrest: "An Electrical Resistance Test for Insulating Oils".

Manchester Literary and Philosophical Society, Social Philosophy Section (at the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Lecture by Miss C. V. Wedgwood.*

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—"Organoleptic Tests in the Food Industry".

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. Ivor Jenkins: "Controlled Atmospheres for Heat Treatment of Metals".

Institution of the Rubber Industry, Preston Section (at the Victoria and Station Hotel, Preston), at 7 p.m.—Mr. H. Jackson: "The Nature and Reason for Ingredients in Rubber Mixings".

Institution of Structural Engineers, Lancashire and Cheshire Branch (at the College of Technology, Manchester), at 7 p.m.—Mr. T. H. Carr: "Civil Engineering, with particular reference to Structural Work for Power Stations".

Institute of Welding, North London Branch (at East Ham Technical College, Barking Road, London, E.6), at 7.30 p.m.—Mr. C. E. Slade: "Developments in Resistance Welding".

Society of Dyers and Colourists, Northern Ireland Section (at the Queen's Hotel, Belfast), at 7.30 p.m.—Mr. J. Boulton: "What Research has Meant to the Practical Dyer and What it will Mean".

Thursday, December 11

Chemical Society (in the Chemistry Lecture Theatre, The University, Liverpool), at 4.30 p.m.—Prof. F. G. Young: "Hormones and Enzyme Action".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "The Physiology of Resistance to Disease in Plants" (to be opened by Prof. W. Brown, F.R.S.).

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers, Installations Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. Allan: "Electrical Engineering Problems in the Tropics".

Institution of Civil Engineers, North-Western Association (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. T. K. George and Mr. K. B. Manyam: "The Rational Design of Settlement Tanks".

Royal Photographic Society, Scientific and Technical Group (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. G. B. McAlpine: "Photography of Small Objects for Reproduction".

Women's Engineering Society (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—Mr. C. Cropper and Mr. G. M. Wells: "Ultrasonics".

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. R. L. Elliott: "Dyeing and Finishing from the Consumer Angle".

Chemical Society, Society of Chemical Industry, and Royal Institute of Chemistry, Edinburgh and East of Scotland Sections (at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. G. Roche Lynch: "Medico-Legal Experiences".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. Adrien Albert: "Modern Knowledge of Protein Structure and its Pharmaceutical Significance".

Royal Institute of Chemistry, London and South-Eastern Counties Section (at Acton Technical College, High Street, Acton, London, W.3), at 7.30 p.m.—Dr. H. Baines: "The Chemist in the Photographic Industry".

Pharmaceutical Society, Manchester, Salford and District Branch (at the Midland Hotel, Manchester), at 7.45 p.m.—Mr. H. N. Linstead: "Pharmacy under the National Health Service".

Friday, December 12

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. F. Heywood: "Textile Machinery Development and Research".

Association of Applied Biologists (in the Surveying Lecture Theatre, Royal School of Mines, South Kensington, London, S.W.7), at 11 a.m.—Dr. E. S. Bunting: "Oil Seed Crops"; Dr. K. Holly: "Control of Weeds in Oil Seed Crops"; at 2.15 p.m. (in the Mathematics Lecture Theatre, Huxley Building, Royal College of Science)—Dr. S. G. Jary: "Insect Pests of Brassica Seed Crops"; Dr. J. R. Busvine: "The Mosquito Eradication Campaign in Sardinia".

Physical Society, Optical Group (joint meeting with the Industrial Spectroscopic Group of the Institute of Physics, in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 3.30 p.m.—Demonstrations and Paper.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. Poole: "The Design, Testing and Calibration of a Combustible-Gas Detector".

Institution of Mechanical Engineers, Applied Mechanics Group (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Papers on "Photo-Elasticity". Mr. W. A. P. Fisher: "Basic Physical Properties relied on in the Frozen Stress Technique"; Mr. R. B. Heywood: "Modern Applications of Photo-Elasticity".

Institution of Electronics, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Prof. R. E. Peierls, F.R.S.: "The Electron and other Constituents of Matter".

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Educational Films: (*a*) "Flame Cleaning of Structures prior to Painting"; (*b*) "Spray Painting Technique" (Commentary by Mr. F. G. Dunkley).

Plastics Institute (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Mr. H. R. Poole: "Silicone Resins".

Institute of Economic Engineering (at Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Miss Patricia Elton Mayo: "The Consultant's Approach".

Paper Makers' Association (Technical Division), Northern Division (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. B. Dixon and Mr. W. J. Binns: "Some Modern Developments in Paper-making Machinery".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. H. Munro Fox, F.R.S.: "Red, Green and Blue Blood"

Saturday, December 13

Biochemical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "The Biochemical Reactions of Chemical Warfare Agents".

British Psychological Society (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Mr. W. R. Geddes: "Incentives in a Changing Native Culture".

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. C. Toyne: "Heat Transfer in Agitated Pans".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer in Physics at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (December 15).

Assistant Chemist in the Plant Protective Chemistry Section—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (December 15).

Professor of Dental Prosthetics in the King Edward VII College of Medicine, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (December 31).

University Demonstrators (2) in the Department of Geography—The Secretary, Appointments Committee of the Faculty of Geography and Geology, Department of Geography, Downing Place, Cambridge (December 31).

Lecturer in Anatomy to teach histology and embryology, a Senior Lecturer in Agriculture, and a Reader in Agriculture, at Makerere College, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (December 31).

Senior Lecturer or Lecturer in Physics at Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 31).

Director, and Assistant Scientific Officers (3), at the Poultry Research Station—The Scientific Director, Veterinary Educational Trust, 232–235 Abbey House, Victoria Street, London, S.W.1 (December 31).

Chair of Philosophy at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (December 31).

Headships of the Departments of Botany, Zoology, Physiology, Anatomy, Pathology, Medicine, Surgery, and Public Health, at Ibadan College, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (January 1).

Lecturers (2) in Chemical Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (January 1).

Superintendent in the Ship Division of the National Physical Laboratory—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2065 (January 7).

Senior Principal Scientific Officer in the Telecommunications Research Establishment of the Ministry of Supply at Malvern—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2066 (January 7).

Ecologist in the Tsetse Control Department of the Government of Uganda—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

General Farm Manager at the Livestock Research Centre—The Scientific Director, Veterinary Educational Trust, 232–235 Abbey House, Victoria Street, London, S.W.1.

Professor of Pharmacology by the Government of Iraq for the Royal College of Medicine, Baghdad—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18525.

Expert in Agricultural Extension and Demonstration Work by the Government of Iraq for the Directorate-General of Agriculture—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18179.

Entomologist by the Government of Iraq for work in the Plant Protection Division of the Directorate-General of Agriculture—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18155.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Abridged Scientific Publications from the Kodak Research Laboratories. Vol. 27, 1945. Pp. 314 + xii. (Rochester, N.Y.: Eastman Kodak Co., 1946.) [243

Fieldiana: Geology. Vol. 10, No. 3: A New Anosteirine Turtle from Manchuria. By Rainer Zangerl. Pp. 13–22. (Chicago: Chicago Natural History Museum, 1947.) 15 cents. [243

Fieldiana: Zoology. Vol. 31, No. 7: The South American Rodents of the Genus *Neotomys*. By Colin Campbell Sanborn. Pp. 51–58. 15 cents. Vol. 31, No. 8: The Sheath-tailed Bat of the Palau and Marshall Islands. By Colin Campbell Sanborn. Pp. 59–62. 10 cents. (Chicago: Chicago Natural History Museum, 1947.) [243

NATURE

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LAND UTILIZATION IN BRITAIN

FOR well over a year public concern regarding the utilization of land in Great Britain has found repeated expression, more especially regarding the claims of the Services, but also those of the Ministry of Fuel and Power and of the various municipalities in connexion with water, power or other schemes. During 1947, in addition to the Town and Country Planning Act, which did nothing to allay concern regarding departmental claims and activities, there have been published the reports of the Hobhouse Committee on National Parks in England and Wales, the Huxley Committee on the Conservation of Nature in England and Wales, the Hobhouse Committee on Footpaths and Access to the Countryside and the Scottish National Parks Committee, under the chairmanship of Sir J. Douglas Ramsay, on National Parks and the Conservation of Nature in Scotland, as well as, more recently, that of the New Forest Committee under Mr. H. T. Baker. All these reports contain much common ground in regard to the dangers of conflict between departmental and national interest, and represent a large measure of consensus of opinion that is both responsible and authoritative.

There are as yet few, if any, signs of a disposition on the part of the Government to deal with the central issues, and to give attention to such important representations and recommendations. The official committees in the reports noted above have shown good cause for reserving for national parks about 5,680 square miles in England and Wales, and 2,000 square miles in Scotland, together with fifty-two conservation areas in England and Wales, amounting to 70,000 acres, and further conservation areas in Scotland which have yet to be specified. According to a statement by Mr. M. V. Osmond, assistant secretary of the Council for the Preservation of Rural England, at a conference in London on November 26, the total Service requirements for training areas and ranges amount to about 1,328 square miles. Of these, only 156 square miles are in Scotland, and no less than 255 square miles claimed by the Services lie in the proposed national park areas of England and Wales. Responsible leaders of the rural preservation movement clearly appreciate the reasons for the larger requirements of the Services. These needs will not be recognized as widely and as fully as they deserve, however, until the Government has made available the promised general picture of the land requirements of the Services and a statement of the principles determining the choice of sites. While choice appears to be piecemeal, there will persist the tendency, however unfounded, to regard the Services as unimaginative enemies of agriculture, amenities, archæology and the study of Nature, and resentment at departments which appear to be judges in their own cause will grow.

There is already too much evidence of the latter tendency in this as in other matters for it to be disregarded lightly by the Government, all the more because a clear lead to the decisive principles has been given by the reports already noted. The

Hobhouse Committee, in its report on national parks, in recommending that the prime charge of national parks should be given to a specific central authority, under the parliamentary responsibility of the Minister of Town and Country Planning, recognized that farming and essential rural industries must flourish unhampered by unnecessary controls or restrictions, and protected so far as possible from the inconveniences that might arise from an increased number of visitors. Other forms of large-scale development and land use, which might affect adversely natural beauty and popular enjoyment, such as water catchment, mineral extraction, military training and commercial forestry, should be accommodated in national parks only under proved national necessity, and even then the greatest care should be taken to minimize their detriment to the landscape.

To that statement no exception can be taken, nor to the Committee's reiteration that the administration of a national park must be for the benefit of the nation and by appropriate national decision and action. The doubts arise rather as to whether, under the parliamentary responsibility of the Ministry of Town and Country Planning, a national parks commission can achieve its planning objectives in the control of the use of such areas. However successful the commission may be in recruiting staff of the character and ability essential, it will need much more powerful backing than the present Ministry of Town and Country Planning has been able to offer in order to resolve the conflicts between national and local interests which may arise in some industrial development or extension of public utilities, and particularly to resist dangerous encroachments of other departments of State. The Committee itself recognizes that the major threats in the type of country envisaged for national parks arise from the activities of Government departments, and it suggests the establishment of a permanent Cabinet or ministerial committee charged with the reconciliation of all claims to the use of land by Government departments, wherever conflicts of interest prove insoluble by the ordinary means of inter-departmental consultation. That may indeed provide a solution, but only if more is done beforehand. The Minister of Defence should at least be responsible for seeing that the demands of Service departments for land are sifted and co-ordinated before they are submitted to any inter-departmental committee; and there must be an end to the practice of departmental requirements for land being formulated without reference to the Ministry of Town and Country Planning.

The Huxley Committee, in its report on the Conservation of Nature in England and Wales, was even more explicit. Within certain designated areas it recommended that further development or economic exploitation should not be begun, nor military occupation planned, before the appropriate scientific authority has been informed and given the opportunity of bringing objections before an impartial tribunal. The Committee does not claim that in these areas scientific considerations should have an overriding voice, but merely that they should be recognized as one of the interests that must be taken into account before final decisions are made upon proposals that are likely to have drastic effects upon prevailing conditions; and it points out rightly that machinery for the resolution of conflicting interests at whatever level can only be effective if the positive claim for scientific consultation in such areas is fully recognized.

It has been the Government's apparent disregard of so reasonable a claim that is responsible for much of the concern with which the question of Service lands is at present regarded. The Huxley Committee proposed that as a matter of urgency the Ministry of Town and Country Planning should communicate to all departments and public authorities concerned the list of sites recommended for preservation and should take steps to ensure that no changes in land use (or extensions of temporary war-time uses) affecting these areas should be sanctioned without the fullest investigation of their possible repercussions on Nature conservation.

The Hobhouse Committee on Footpaths and Access to the Countryside was likewise impressed with the urgency of the situation and the dangers attendant on delay. In particular, its recommendations regarding long-distance rights of way, such as the Pennine Way recommended in the Scott Report, are endangered by some of the recent claims of the Services; and the survey which it recommends should clearly be undertaken as a matter of urgency by the Ministry of Town and Country Planning. Once again, observations on conflicting interests in land are eminently reasonable; indeed, they may well be held to concede too much to water undertakings, the Forestry Commission and other special interests. It will be noted that the Committee firmly recommends that public access should be secured over all training grounds except where live ammunition is used, and that local permission should also be granted, where practicable, for public access over artillery ranges when firing is not in progress. Moreover, once again attention is directed to the necessity of arrangements to ensure that planning authorities have full opportunity of making representations, and, if desired, of being heard in regard to the effect of Service departments' proposals on public access.

The Hobhouse Committee in its report estimates the area of land required by the Service departments for training purposes in England and Wales as in the neighbourhood of a million acres, mostly uncultivated land and including much of the finest country for rambling access. Whether or not it is due to the lesser demands on such areas in Scotland, the Scottish National Parks Committee and the Scottish Wild Life Conservation Committee are much less forthright. They assume, rather than recommend, that the Secretary of State for Scotland is competent to ensure that other Government departments will consult him, as planning minister for Scotland, about any proposals of their own for development, and that it will be the normal practice for him to consult any national parks commission and park planning committee before giving any decision. They recommend, indeed, that national park areas should be treated as particular areas in which statutory undertakings are not exempt from planning control, and that it should be obligatory on such undertakings and on Government departments to consult the national parks commission before giving approval to any development proposed in such areas. The assumption that land in such areas owned by Government departments, local authorities and statutory undertakings will be developed and administered in conformity with national park requirements, to say the least, is a little naïve and scarcely accords with recent experience.

The ideas and recommendations of these two Committees are in line with those of the National Parks Committee for England and Wales, and include the provision of the long-distance paths and of public access to all uncultivated land in a national park area, subject to suitable regulations. On water catchment areas, indeed, the Committees are disposed to be less lenient to the water undertakings than is the Hobhouse Committee. Finally, it may be noted that the New Forest Committee in its report urges that all war-time encroachments which are such a serious feature in the present condition of the Forest, including the bombing ranges, the aerodromes, the War Agricultural Executive Committee's cultivations, and a prisoner-of-war camp and stores depot, should cease at the earliest possible moment and the lands affected should be restored to their former state. Further, to ensure that scientific interests are not adversely affected by drainage, burning plantations or other changes, the whole Forest, open and enclosed, should be declared a Nature reserve.

The relevance of this particular report, apart from the similarity in its general trend, lies in the illustration it affords of the imperative necessity of immediate action to safeguard areas and amenities, some of which are unique in Britain and many of which are threatened from several quarters. It is pertinent to remind the Government that good intentions are no substitution for sound judgment and wise administration; it is also true that the feeling of frustration and exasperation which so many piecemeal proposals are engendering and spreading, in the absence of any indication of some governing policy and some overriding authority competent to resolve issues in the national interest are, like other factors in the general situation, undermining the incentive to work. The case for national parks rests at least in part on the stimulus to health which free access to unspoilt natural beauty can afford. Already measures which, on the plea of the economic crisis, the Government has imposed, have restricted the means and freedom of access to the countryside for many thousands of workers in the industrial towns of Britain. The Government has rightly called for increased effort and for longer hours of work at the present time; it cannot wisely ignore the importance of providing as fully as possible the means for enjoying those types of recreation which in a war-weary and increasingly drab and regulated world can bring spiritual as well as physical healing to jaded minds and bodies.

This aspect was strongly urged by Mr. Edward Evans in relation to the Norfolk and Suffolk Broads in a debate on the adjournment in the House of Commons on November 25. He pleaded with the Minister of Town and Country Planning to restore to the public the rights of access which were being impeded by private interests as well as by local authorities, and for measures to deal effectively with the growth of weeds and other aquatic vegetation. Mr. Evans made it clear how grave are the consequences of neglect to deal with such insidious encroachments and how important is the time factor. The Broads are one of the areas recommended for inclusion in the national parks scheme, and although the Minister of Town and Country Planning indicated that his Ministry agreed in general with the recommendations of the Broads Preservation Committee and promised a definite reply later to the points raised, the terms of his reply at least implied some doubt as to the Government's readiness to undertake legislation on the report of the National Parks Commission. If such legislation was undertaken, however, he committed the Government to the inclusion of the Broads as one of the national park areas.

Much the same arguments were urged by Mr. S. Swingler on the following day in regard to the requisitioning of parts of Cannock Chase and the question of public access to that area, 24,000 acres of which are scheduled as a conservation area for wild life. Mr. S. Swingler pointed out that while a large part of this relatively unspoiled countryside had for some time been maintained by the Forestry Commission, 1,000 acres are still retained by the Service departments and public access is denied to a much larger area. It had recently been disclosed that the Services had claims on nearly 2,000 out of the 30,000 acres; all that Mr. Swingler said about the importance of public access for the surrounding large urban areas was strongly supported by Mr. H. O. Hughes and other speakers who followed. The Parliamentary Secretary to the Ministry of Town and Country Planning, in replying, was able to dispel some anxiety as to the encroachments on Cannock Chase itself, but it still does not appear that the Government realizes the extent of public feeling or the gravamen of the criticism of piecemeal procedure.

This is one reason—a very practical and short-term one—why the prospect of much natural beauty being damaged or rendered inaccessible is so alarming at the present time. Fortunately, the position is not yet irretrievable. There have been instances of forbearance and understanding which demonstrate recognition on the part of military authorities that the love of natural beauty is a valid consideration, as tangible if not necessarily as weighty as agriculture, mining or defence; and the reports already noted bear evidence that the preservers of the countryside recognize that the Service authorities, like public undertakings, are servants of the State, carrying out to the best of their abilities the duties which their service lays upon them.

With such considerable measure of goodwill and elbow room to work in, provided only the individual proposals are not considered in isolation but in relation to other alternatives in the national picture, there should be fair prospects of general agreement between the interests involved.

QUANTUM MECHANICS

The Principles of Quantum Mechanics

By Prof. P. A. M. Dirac. (International Series of Monographs on Physics.) Third edition. Pp. xii+312. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 25*s.* net.

IT is now twenty years since the theory of quantum mechanics was founded, and not much less since the first edition of Dirac's book was published. Ever since, it has been a classic of scientific literature.

The importance of the development which has taken place in these twenty years can scarcely be fully gauged at present. The whole of the atomic world has been opened up for exact treatment and understanding in a way which can only be compared with the development of mechanics since Newton; and so rapid has the progress been that already large-scale practical applications of quantum mechanics have been made. Moreover, and more important still, there is no doubt that quantum mechanics implies a profound departure from the way of thinking which is characteristic of classical physics. This feature, the philosophical consequences of which are up to now scarcely fully realized, will have consequences which will perhaps make themselves felt only after a considerable time, just as the impact of exact science on European thought and life became noticeable only a long time after Newton.

The text-book literature on quantum mechanics is still in an unsatisfactory state. The much-wanted text-book, of some 1,000 pages, giving a balanced account of all the important aspects of the theory and a selection of the most typical applications, has not yet appeared. Dirac's book certainly does not profess to occupy this place. It is not a book for the student who wants to learn quantum mechanics; but no one who wishes to have a thorough insight into the subject, provided he has gained a first knowledge of it, can afford not to study Dirac's book very carefully. The condensed and crystal-clear style, characteristic of the author, makes delightful and satisfactory reading, especially for someone who, (like the reviewer) thinks that this, rather than the descriptive style, is more appropriate for subjects of this kind.

The author has chosen a straight, one-line approach to the subject, and this is the more formal axiomatic approach. It is very satisfying from the logical point of view, but not, of course, the best pedagogical way to introduce a student to quantum mechanics. As in the previous editions, the first 100 pages or so are devoted to the 'framework' of quantum mechanics, that is, the general principles and properties of all those mathematical entities which occur in quantum mechanics: the eigenvectors (the word eigenfunction or wave-function does not occur until much later), linear operators, observables, etc. So, for example, the book begins with the superposition principle of states, and continues by explaining (and postulating) how the 'observables' are represented by linear operators. The principle of indeterminacy is introduced from the start. Nothing so far about dynamics and the equations of motion, which will fill the framework with physical content. All this is much in the same style as in the previous editions, except for a notable change in the notation. The author uses the 'bracket notation' (rather 'bra-c-ket' notation) which he has invented for the purpose. The well-known type of quantity ($\psi_a^* Q \psi_b$) occurring so frequently in quantum mechanics, where ψ_a, ψ_b are the wave-functions of eigenstates a, b, and Q a linear operator, are denoted by $<a|Q|b>$. The author rightly lays emphasis on the fact that all that matters here is not what function ψ_a is, but what states a and b are and what Q is. It is also emphasized that ψ and ψ^* are never mixed up in quantum mechanics; they occur *always* after and before the operator Q, respectively, whereas the fact that ψ^* is the complex conjugate to ψ is less fundamental. This is brought out by the notation $<$ and $>$. The vectors $<a$ and $b>$ are called 'bra' and 'ket' from the word 'bracket', which describes the notation used in print. Its two syllables, one of them mutilated (for symmetry reasons, obviously) by the loss of the letter 'c', are promoted to the full rank of nouns and important mathematical and physical content is conferred upon them.

In the second third of the book the laws of quantum dynamics are developed. After an exposition of the equations of motion, the angular momentum and the spin are introduced, and a few applications to the hydrogen atom, perturbation theory and the general theory of collisions (with the important representation in momentum space) follow. Also here the main difference compared with previous editions is the notation.

In the last part of the book the many-body problem, the relativistic wave equation and the theory of radiation are treated. Here important alterations and additions are made. In the treatment of an assembly of 'bosons' ('bosons' and 'fermions' are particles obeying Bose and Fermi statistics), the elegant and powerful method of Fock is used which the author has himself applied and developed in his work since 1940. This is applied to the radiation field, that is, an assembly of photons. The author treats a photon on exactly the same footing as any other type of particle obeying Bose-statistics, which is justified in quantum theory. On the other hand, one might perhaps also mention the difference that exists between charged and neutral particles when talking of them as particles in the classical sense. In particular, it seems that photons cannot in the classical limit be considered as particles at all in the sense that a charged particle can.

The last few sections of the book contain somewhat controversial matter. In the treatment of the interaction of radiation with electrons, the author uses the λ-limiting process which was originated by Wentzel, in order to remove the infinite self-energy of a classical point-electron, and was later extended to quantum theory by the author. In reading these sections of the book, one gets the impression that the author firmly believes in this procedure as a remedy for part of the difficulties of quantum electrodynamics; whereas it is mentioned at the end of the book that, nevertheless, fundamental difficulties occur here. It might be mentioned that not all who work on this subject share the author's opinion about the physical correctness of the λ-procedure, although this is, of course, a most interesting and stimulating theory.

In the new version, as in the old ones, Dirac's book will play the part it has played before: it is the standard work in the fundamental principles of quantum mechanics, indispensable both to the advanced student and the mature research worker, who will always find it a fresh source of knowledge and stimulation.

W. HEITLER

MODERN GENETICS

Genetics

By Edgar Altenburg. Pp. xii+452. (New York: Henry Holt and Co.; London: Constable and Co., Ltd., 1946.) 16*s*. net.

THE teaching of all subjects is bound to be influenced by its object. That object ostensibly has always been to expand the mind of the pupil, accustoming it to new modes of thought and to their application in practice. For such a purpose the new development of the science of genetics is remarkably well suited. All types of scientific method have been used in this development and all aspects of human life and thought are affected by its practical application. The only difficulty is that teachers are lacking, and most of those who want to learn have to turn to books. That is why a new book on genetics is so important at the moment.

Dr. Edgar Altenburg, the author of the present work, comes from the famous *Drosophila* laboratory at Columbia. His book is intended for university students. It follows a plan now commonly adopted for such books in the United States. It omits references to original papers, devoting, on the other hand, as much as a third of its matter to summaries of each chapter and to statements of problems, or examination questions; both of these are accurately indexed—more so, indeed, than the text.

It might be objected that this method encourages the novice to acquire fixed and final ideas on each aspect of the subject before the matter is further developed. This objection does not, however, apply to the present case, for in fact matters are not further developed. In the general treatment ideas are not joined together. A work on anatomy or systematics would not perhaps be seriously impaired in its educational use by such incoherence. A work on genetics, however, is bound to suffer. That the author has never felt any difficulty of this kind is apparent from such a sentence as the following, from Chapter 1 (which he puts in italics as being of special moment), "We may then define heredity as the transmission of the germ plasm from parents to offspring"; and the germ plasm he has defined six lines earlier as "the hereditary material". Similarly, in the text of Chapter 2, he tells us that "The question 'Which is more important, heredity or environment?' raises a problem which really has no answer"; but in the summary of the same chapter the wisdom of this remark has been distilled into "Heredity and environment are equally important in the development of the individual". You pay your money and you take your choice. Again, in Chapter 11, the author devotes a great deal of trouble to explaining how crossing-over takes place between paired chromosomes at meiosis. But in Chapter 1 he has already described the two divisions of meiosis as reductional and equational, a terminology which has no meaning where crossing-over takes place. Genetics used to be like this thirty years ago. But need it be so to-day?

So much for modern aspects of the subject—and Altenburg claims to be really modern. Genetics, however, is less modern, as well as more modern, than he imagines. The theory of natural selection, an integral part of modern genetics, can be usefully connected with the work of Darwin. The chromosome theory of heredity can likewise be usefully connected with Weismann and the classical school of German cytologists. Yet the contributions of Weismann and Darwin are referred to only among "problems". There is no argument in the text which requires their introduction: Darwin is mentioned only as the author of the pangenes and the father of a large family.

In place of ancient history, Altenburg offers the most recent of his own ideas: "Some species seldom mutate, as judged by the fact that they have so few varieties. This, for example, is true of the goose. By contrast there are many varieties of chickens, due perhaps in part to a relatively higher (*sic*) mutation rate" (p. 347). Has a conclusion been reached? Probably not. But certainly it would be difficult to create more false impressions in three sentences. One wonders what the author would have made of Fisher and Haldane, Sewall Wright and Vavilov, if he had mentioned them.

Altenburg's book has one thing in common with genetics. It is founded on Morgan. It does not, however, integrate Morgan's ideas with the great achievements of those who came before him and of those who have come after him; on the contrary, it merely fills them out with such intellectual roughage as has been quoted. Such matter can be read, to be sure, without danger of expanding the mind of the student or the teacher, or of finding practical application. But it is not modern genetics.

C. D. DARLINGTON

PRACTICAL VERTEBRATE ANATOMY

Atlas of Outline Drawings for Vertebrate Anatomy

By Prof. Samuel Eddy, Prof. Clarence P. Oliver and Asst. Prof. John P. Turner. Pp. vii + 80. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 12*s*. net.

THIS is one of those books of outline drawings which are so popular in the United States. There is neither text nor indication of how the dissections should be carried out; but for each animal unlabelled diagrams are given of the important external and internal features, including the system of skeletal muscles. The main types dealt with in detail are *Amphioxus*, the dogfish, *Necturus*, and the cat.

From almost every point of view the book is unsuitable for use in Britain. Of the four main types, only *Amphioxus* and the dogfish can easily be obtained here, but an even more serious criticism is that of the use for which the book is designed. Its aim, as set out in the preface, is to save the student the necessity of "laborious drawing", and to meet the needs of those "with little drawing ability". All that remains to be done is to add labels to the diagrams provided. Such a method of undergraduate training cannot be too strongly condemned. Whether or not the student happens to be naturally clever with his pencil matters little. What does matter is that he should be forced by the act of attempting to draw to make close observation of the specimen before him. In no other way can he easily be trained to pay attention to detail, and in no other way can his attention to detail be checked. It is also not unimportant in the training of any zoologist that he should be given abundant practice in the craft of making clear drawings of his work. Whatever part he may ultimately play as a zoologist, he will have constant need of this ability.

For these various reasons this new atlas cannot be recommended.

W. S. BULLOUGH

Modern Paper-Making

By Robert Henderson Clapperton and William Henderson. Third edition. Pp. xii + 380. (Oxford: Basil Blackwell, 1947.) 30*s.* net.

THIS is the third edition of a book first published in 1929, when it at once established itself as a standard work on the practical aspects of paper-making. It owes this status to a somewhat rare combination of qualities, for not only does it contain valuable information, but also this information is imparted in a straightforward and understandable style. Since the authors are practical paper-makers of wide experience, it is understandable why their book has played such an important part in educating a younger generation of paper-mill workers.

It is with this in mind that a reviewer's comments must be judged. It may be argued that chemistry and physics should figure more prominently, especially in view of the increasing importance of the paper-mill laboratory. The answer is that the treatment is adequate, having in mind the requirements of readers of the above type. The opportunity of a third edition might also have been used to make some reference to the complete change in the raw materials situation since 1939, and in particular to the importance of straw and the wood pulp shortage, since the former has probably come to stay and the latter has reacted so strongly on the everyday life in Great Britain. On the other hand, the writers have confined themselves so strictly to practical paper-making matters in other respects that their decision that there has been insufficient change in general paper-making practice since 1941 to warrant rewriting the book must be accepted as wise in the circumstances.

The scope of the book covers fibrous raw materials for paper, boiling, bleaching and washing methods, beating and other beater operations, the paper machine (six excellent chapters, including one on newsprint manufacture), hand-made paper, finishing methods, paper testing, water supply and soda recovery. There are 157 clear illustrations, and the book concludes with an appendix of useful tabular matter, and an index.

It is a pleasure to be able to recommend this book unreservedly to all interested in the practical aspects of paper-making, and particularly to the student.

JULIUS GRANT

Lecture Experiments in Chemistry

Third edition, with Supplement. By G. Fowles. Pp. xvi+612. (London: G. Bell & Sons, Ltd., 1947.) 25*s.* net.

IN this, the third edition, some sixty experiments have been added as a supplement at the end of the book, and the bibliographies have been brought up to date. On the historical side, information which the author has found in "Chemical Pastime", by F. Accum, 1817, has led to the revision of the dates to a number of the experiments.

In Part 1 of the Supplement there are many valuable experiments, some of which deal with subject-matter not previously treated in the book, as, for example, osmotic pressure, indicators, soluble anhydrite as a drying agent, and the cleaning of mercury, while others are supplementary to those given in the previous edition. In this category all teachers of general chemistry will welcome the experiments on electrolysis with J. A. Mattuck's improved cell.

In Part 2 of the Supplement, experiments are described which will serve as an introduction to the effects of temperature, pressure and concentration on equilibria. In general this section is well done, but it is a pity that the experiments on the solubility of hydrogen chloride and sodium nitrite will not make it clear to the student that it is the heat change at the point of saturation which decides the effect of temperature on the solubility of a substance.

The previous editions of this book have received a very warm welcome and the reviewer is confident that this one will meet with a similar response; it is, indeed, a book which no teacher of general and inorganic chemistry can afford to be without. The publishers are to be congratulated on the good quality of the paper and binding.

A. C. C.

Peach Orchards in England

Being an Account of How to Grow Good Peaches in this Country. By Justin Brooke. Pp. 86 + 12 plates. (London: Faber and Faber, Ltd., 1947.) 7*s.* 6*d.* net.

MR. JUSTIN BROOKE is an enthusiast with a sense of proportion. He grows fruit commercially on a considerable scale near Newmarket, has grown and marketed peaches since 1936, and outlines, in the present volume, details for a great expansion of the crop in Great Britain. The variety Peregrine yields heavy crops and is self-fertile; it is best grafted upon the Broad Leaf Mussel stock. The author considers that peach blossom is rather less sensitive to damage by spring frosts than Victoria plum blossom. Manuring should be directed towards the production of vigorous growth, and pruning should also be subordinated to the same end. Thinning of fruit to one every four inches of branch is necessary, and the would-be grower will find adequate detail of all cultural aspects, and of pest and disease control, in the text and in the twelve excellent half-tone plates. Mr. Brooke points out that mechanized corn-growing and fruit production go well together, and it is greatly to be hoped that some of his readers will be stimulated to repeat his experiment in other parts of Britain. It would indeed be a national asset if peaches were within the economic reach of all members of the community.

Les plantes et la vie

Par Prof. Florian Cosandey. (Sciences et médecine, Série des Sciences naturelles.) Pp. 190+10 plates. (Lausanne: F. Rouge et Cie.; Paris: Masson et Cie., 1945.) 210 francs.

THIS book, as stated in the introduction, is written for readers used to university lectures, but who are not specializing in science. It is written by the professor of botany at the University of Lausanne. The material is well chosen and the style attractive. The fundamental physical and chemical features of plants are described and illustrated by diagrams which bring out these relationships with clearness. Such matters as vitamins and hormones are briefly introduced to the reader, and the importance of molecular films is discussed in relation to the surface activity of the vacuole and cytoplasm. The general metabolism of the plant is treated in outline and the characteristics of organic acids, albumins, proteins, glucosides and alkaloids described. A chapter follows dealing with cell structure. There is a preliminary chapter which gives an outline on physico-chemical conceptions which will aid the non-scientific reader to appreciate the following chapters.

It appears that this is only one of a series of similar books dealing with various aspects of science and medicine.

AN ESSAY IN CORRELATION ARISING FROM ALKALOID CHEMISTRY*

By SIR ROBERT ROBINSON, F.R.S.

THE incident which I wish to describe is of peculiar interest, because it transpires that the behaviour of a natural product can only be explained in the light of knowledge comparatively recently acquired and never previously brought to bear in the analysis of a structural problem.

When we break up molecules in order to examine the fragments, or submit them to transformations in order to recognize the reactive groups, the changes that occur usually follow relatively simple rules; the pieces, for example, are clearly related to the whole from which they were obtained. In certain classical instances the picture has been confused by rearrangements of atoms within the molecule in the course of some of the changes examined.

But these molecular shifts also follow laws which have gradually been brought to light, and it has always been possible to integrate the data in terms of a particular molecular structure.

Thus camphor showed itself to be a chemical proteus and at one stage it was not clear which manifestation corresponded to the reality. The vagaries of this molecule which proved most puzzling were explained by Lapworth. Camphor and all its derivatives have been synthesized and thus all dubiety was resolved.

Brazilin is another molecule which twists itself into contortions, and here again we can follow all the varied transformations, and we have the confirmation of synthesis, not, it is true, of brazilin itself, but of many of its more important derivatives.

But the star performers in the team of molecular acrobats are undoubtedly the alkaloids of the morphine group, and I shall speak especially of thebaine.

In 1923–25 I discussed the chemistry of morphine, codeine and thebaine with John Masson Gulland, whose untimely death in a recent railway accident was so great a tragedy. We arrived at a solution of the problem which has since been generally accepted, but there is no synthetic proof that applies to the thebaine structure itself. The certain knowledge from analysis and synthesis relates to the various transformation products, and the molecular structures of many of these are established beyond doubt. The validity of our formulæ, therefore, is estimated entirely on their success in interpretation of a complex of data. With an emendation in one group of products, suggested by Schöpf and gladly accepted, it seemed that the book was all but closed. Yet the most remarkable rearrangement of the molecule and one of the most extraordinary changes yet encountered in the whole domain of organic chemistry remained to be recognized. It subjected the Gulland–Robinson formula to a very severe test, and its triumphant emergence from the ordeal was at one time in doubt and has only been guaranteed during the last two months.

In 1905 Freund treated thebaine with phenylmagnesium bromide and obtained a new base, phenyldihydrothebaine, which was just thebaine to which the elements of benzene (C_6H_5, H) had been added. Similar substances were made later using other organo-metallic reagents, and Lyndon Small and his collaborators have carefully re-examined and extended the series. They have established some intriguing stereochemical relationships and corrected mistakes of other workers.

In 1943, in the course of a visit to Washington, I was privileged to hear of Dr. Small's results and to examine the detail of his brilliant experimental work. Two conclusions appeared to me then to be inescapable; but the full solution of the mystery remained elusive. In September of this year Dr. Small kindly sent me the manuscript of a paper intended for publication in the *Journal of Organic Chemistry*. He had been unable to make any use of my views; and further correspondence showed why that was so, and also led to the understanding that the present disclosure should be made. A new idea, based on the postulates of 1943, then occurred, and the validity of this has recently been indicated by a crucial experiment.

The first of the inescapable conclusions to which I have referred is derived from a comparison of thebaine with phenyldihydrothebaine. The latter is outstandingly more stable. It is hard to hydrogenate in the presence of a catalyst (thebaine is easily attacked), and when reduction does occur all that happens is a break of a C—N bond. Thebaine is very easily hydrolysed as an enol methyl ether; but although phenyldihydrothebaine contains this methoxy group (also one other OCH_3 and a phenolic OH), it is not hydrolysed by hot concentrated hydrochloric acid. But hot hydrobromic acid produces the change $(OCH_3)_2(OH) \rightarrow (OH)_3$, and the action of diazomethane on the trihydroxy-compound gives a trimethoxy-compound which is the methyl ether of phenyldihydrothebaine. From these facts it is perfectly clear that the near-aromatic nucleus of thebaine, which bears the hydrolysable methoxyl, has become truly aromatic in phenyldihydrothebaine.

The second conclusion follows logically from the first, considered in the light of other data. Phenyldihydrothebaine is optically active and by Hofmann's exhaustive methylation procedure it gives a series of optically active derivatives; this is even true of the second stage in which nitrogen is eliminated. The process is $\text{C—C—N—C—C} \longrightarrow \text{C=C} \vdots \text{NMe}_3 \vdots \text{C=C}$. The two double bonds in this optically active product can easily be shown to be present by diagnostic tests.

Now phenyldihydrothebaine is a C_{25} base and one carbon atom is in $:NCH_3$ (now lost), two carbon atoms are in OCH_3 groups, and by hypothesis eighteen carbon atoms are in three benzene rings (two of the thebaine skeleton and the phenyl group introduced by the reagent); that leaves only four carbon atoms for the two double bonds. Hence exhaustively methylated phenyldihydrothebaine cannot contain an asymmetric carbon atom and it must owe its optical activity to an *asymmetric molecule* of the type familiar to synthetic chemists and stereochemists but never before encountered in the study of a natural product.

It is easy to guess what kind of an asymmetric molecule is present. Thebaine is easily degraded to phenanthrene derivatives (such as I) and these in their turn are derived from diphenyl (II).

In 1922 Christie and Kenner showed that the dinitrodiphenic acid (III) could be resolved into optically active forms. They also pointed out that this result was explicable if the two rings are assumed to be co-axial (as shown by the dotted line) but not co-planar. In 1926 Turner and Le Fèvre, Bell and

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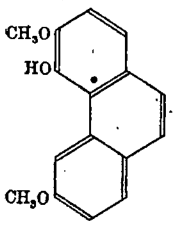
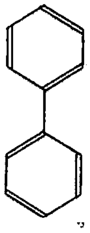
* From the presidential address to the Royal Society, delivered on December 1.



(I)



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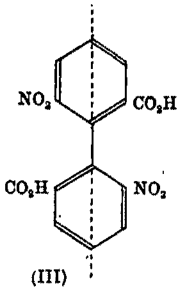


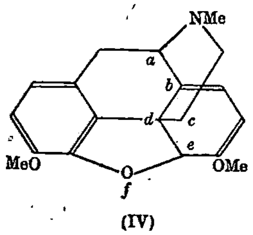
(III)

Kenyon, and Mills developed the hypothesis that restricted free rotation of the phenyl groups is conditioned by the position and size of the substituents. It is well known that this hindrance theory harmonizes all the extensive experimental data.

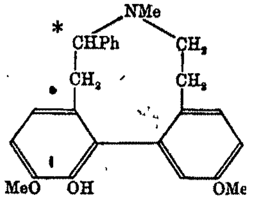
We arrived at the restricted diphenyl idea as a plausible explanation of the optical activity of the end-product of the Hofmann degradation; but there is strong evidence that it must also be applied to phenyldihydrothebaine itself.

Small and his collaborators have shown that Freund's phenyldihydrothebaine is a mixture of two isomerides (equated in various ways, as by reduction, or exhaustive methylation) which he calls (+) α and (+) δ. On heating, (+) α is partly changed to the optical antipode of (+) δ; similarly (+) δ goes partly into the optical antipode of (+) α. The equilibria, reached from either side, favour the α forms. Small clearly recognizes that these changes are partial racemizations but appears to think it possible that a number of asymmetric centres could be inverted in step. He calls the optical antipode of (+) α, (−) α; but it is preferable to term it (−) δ. Thus +, − and α, δ can be taken to be symbols representing left-hand or right-hand at each of two sources of dissymmetry. The partial racemization of (+) α gives then (−) α. These facts alone suggest that the phenyldihydrothebaine molecule contains two sources of dissymmetry and only two; one of these (represented by +, −) is a non-co-planar diphenyl configuration, and the other (represented by α, δ) is an asymmetric carbon atom. We are able to substantiate this view, and the substance is therefore the first in which molecular dissymmetry, and that due to an asymmetric carbon atom (also, strictly speaking, molecular), co-exist. The theory extends to this case without modification; there are the usual numbers of isomerides, 2^n, where n is the number of sources of dissymmetry, not necessarily all asymmetric carbon atoms. This principle is quite obvious but has not previously been enunciated, chiefly because the mixture of asymmetric types is itself new.

All these and many other facts had to be taken into consideration in the endeavour to find a structure for phenyldihydrothebaine, and it would take too long to carry the argument through all its stages. It will be stated more fully elsewhere; meanwhile phenyldihydrothebaine is believed to be (V) and its formation from thebaine (IV) is the result of molecular rearrangement of quite a new type.



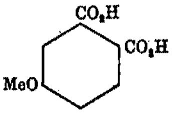
(IV)



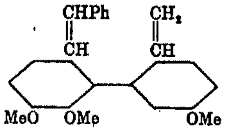
(V)

It was first formulated as a likely process from the electronic point of view. In words: the migrating ethanamine chain is cationoid, (*c*) is joined to (*b*) by means of the electrons of the link (*a b*); the electrons in (*c d*) go to (*d e*) and fulfil the demands of aromaticity of the nucleus; electrons (*e f*) are then taken by the oxygen atom which acquires a negative charge (on decomposition of the complex by water, a proton is attached to oxygen); the phenyl anion brings a new electron pair to (*a*), replacing those lost to the migrating group (*c*). This connected series of changes can be thought of as starting at either end; namely, attack by Ph—, or assumption of a negative charge by oxygen. As in many other migrations in this group, the driving force is doubtless the tendency of the near-aromatic group to become fully aromatic. The formation of isomerides is due to construction of the —CHPh— group in each of the two possible senses, the diphenyl skeletons being configured in one sense only.

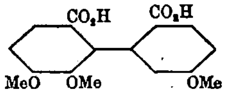
The formula (V) is perfectly satisfactory; examination of models shows that the nine-membered ring allows the phenyl nuclei to be disposed at right angles or at any intermediate angle without strain; there is one asymmetric carbon atom marked * in the formula (V); all the chemical properties and transformations receive natural explanations. But there was thought to be one important exception, and because of it Dr. Small was not disposed (some time before the complete theory was available) to accept the postulation of the two aromatic nuclei. The ultra-violet absorption of phenyldihydrothebaine gave no indication whatever of the appearance of a new aromatic ring in conjugation with the first. This ought to have been thought decisive, but as it conflicted with other equally definite evidence, something had to be jettisoned. Actually a further correlation is possible, and the parts now fit together like a Chinese puzzle made in ivory.



(VI)



(VII)



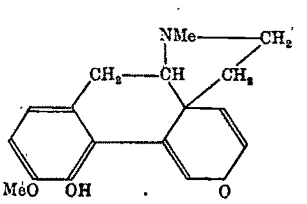
(VIII)

I am indebted to Dr. J. W. Cornforth for pointing out that non-co-planar diphenyls do *not* exhibit normal ultra-violet spectra. This was first noted by Picket, Walter and France (1936), and a clear case is given by O'Shaughnessy and Rodebush (1940). In this example a large ring of eighteen members is formed by a bridge across the *m*-positions of a diphenyl derivative. There is no diphenyl band and only end-absorption.

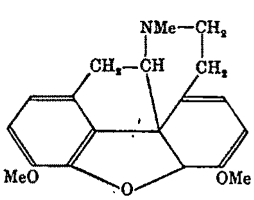
In the last few weeks we have sought and obtained experimental confirmation of the structure (V). Mr. K. W. Bentley has oxidized phenyldihydrothebaine with potassium permanganate and obtained benzoic acid, benzaldehyde, and 4-methoxyphthalic acid (VI). This was identified very thoroughly with an authentic specimen.

By exhaustive methylation, including that of the phenolic group, an optically active product (VII) (made by Freund but stated to be optically inactive) was obtained, and oxidation of this by permanganate in acetone afforded a trimethoxydiphenic acid (VIII). These are very cold, hard facts, and it is to be feared that in the future they will be cited first and all our interesting arguments will be forgotten.

One further punctilio. The thebaine transformations are like the variations of a chess problem in that they have a common key-move. Are we justified in assuming that the problem as set has a unique relation to the variations ? Is the thebaine structure proposed by Gulland and Robinson the only one which serves to explain the whole of the results ? The key-move is the migration of the ethanamine chain from (*d*) to (*b*) in (IV) ; it is only the position *after* the migration that we have proved to be correct. Taking everything into consideration, one alternative can indeed be seen. This can best be explained by reference to the intermediate (IX) now postulated in the complex changes that thebaine undergoes in acid solution.



(IX)



(X)

(IX) arises from (IV) by migration from (*b*) to (*d*) and by hydrolysis. It could equally well arise from (X). The only way of distinguishing between (IV) and (X) seems to be by a study of the α- and β-methylmorphimethines ; and the optical data on these substances strongly support (IV) and would remain inexplicable on the basis of (X). According to Dr. R. Strauss, the ultra-violet absorption of α-methylmorphimethine is not styrenoid and would be consistent with the arrangement, φ.C.C:C.C:C—. On the other hand, that of the β-isomeride shows strong conjugation consistent with φ.C:C.C:C.. The skeleton of (IV) permits these rearrangements and structural elements, but that of (X) does not. The question is related to that of biogenesis and further inquiries must be instituted.

THE INTERNATIONAL METEOROLOGICAL ORGANISATION

MEETINGS IN TORONTO AND WASHINGTON

THE meetings of the International Meteorological Organisation which were held in Toronto and Washington between the beginning of August and mid-October 1947 were of unusual interest, not only on account of the results achieved, but also on account of some of the precedents that were created. It was the first time in its seventy-five years history that any of the constituent bodies of the Organisation had met in the New World, and it was also the first occasion that all ten of the technical commissions had gathered together concurrently.

During the War, the activities of the Organisation were seriously curtailed, but as soon as possible after the return of peace, steps were taken to set its machinery in motion once again. An Extraordinary Conference of Directors took place in London during February 1946 ; new members of the International Meteorological Committee were elected and the technical and regional commissions were reconstituted. This Conference thus cleared the way for a resumption of the international procedures in operation before the War and for the world-wide introduction of improvements in the field of scientific meteorology made by certain countries during the War.

The objects of the meeting at Toronto and Washington were therefore to review and consolidate the progress made since the London conference, to make plans for the future and to consider the structure of the International Meteorological Organisation and its relationship to other international associations.

The meetings of the ten technical commissions in Toronto were spread over six weeks in August and September, and were attended by 179 delegates from forty-four countries. The scope of the proceedings was so wide and the discussions so detailed that even a summary of the activities of each commission would be too lengthy, and attention must therefore be restricted to an arbitrary selection of the main items.

The Aeronautical Commission, which was in session for three weeks, undertook the preparation of a common text for regulations to be adopted by both the International Meteorological Organisation and the International Civil Aviation Organisation for the provision of meteorological facilities to aviation. Codes for the transmission of weather reports to and from aircraft, and for the transmission of terminal and route forecasts between ground stations and to aircraft in flight, required lengthy discussion before agreement was obtained. The Commission for Maritime Meteorology dealt with such problems as marine climatology, the reporting of sea ice by ships, the measurement of ocean waves and swell, and means of increasing the frequency and accuracy of weather reports received from ships. The operation of ocean weather ships and their most suitable stations were also discussed.

The construction of a basic code for weather observations, with specifications for the various elements to be reported, was one of the chief tasks of the Commission for Synoptic Weather Information, and a code acceptable to all countries was eventually devised. Other subjects considered included methods of representing upper-air data on charts, the standard times of synoptic reports and the arrangements for the collection and distribution of meteorological information. The Commission for Instruments and Methods of Observation was formed at the London Conference in 1946, and met for the first time at Toronto, although in the intervening period much work had been done by correspondence. A comprehensive agenda had been prepared, and the Commission surveyed the whole field of meteorological instruments. The discussions usually turned on questions of standardization ; but it was generally felt that only a limited degree of standardization should be the present objective, because much of the equipment in current use was relatively new and capable of further development. It was agreed, however, that comparison of different types of *radio-sonde* is necessary, and recommendations were made for the design of a simple reference instrument. Problems of visibility measurement were also discussed and changes in international practice recommended.

The work of the Aerological Commission has grown in importance owing to the increase in the volume of data relating to the free atmosphere. The regular meetings of the Commission considered, *inter alia*, definitions and specifications of water vapour in the atmosphere, values for certain physical constants in common use and the operation of meteorological reconnaissance flights; but additional sessions were arranged for lectures and discussions at which the trends of modern research were studied.

The increased attention which economic concerns are devoting to meteorology was reflected in the work of the Climatological Commission, which formed a permanent Sub-Commission to examine the applications of climatology to health and industry. The remaining Commissions—those for Hydrology, Agricultural Meteorology, Bibliography and Publications, and for the Projection of Charts—also held successful meetings and made valuable recommendations.

The technical commissions finished their work in Toronto on September 15, and a week later the Conference of Directors opened in Washington. The agenda contained, in addition to some four hundred resolutions submitted by the technical commissions, a proposal to form a World Meteorological Convention, and another to seek affiliation to the United Nations.

With regard to the Convention, the International Meteorological Organisation has hitherto been a semi-official association of Directors of Meteorological Services, but the increased importance of meteorology in a number of directions has led to a widespread belief that the Organisation should be replaced by an inter-governmental body which would be in a more favourable position to enlist official support. The proposal for a Convention gave rise to protracted discussion, and it was clear that some of the delegates were not without misgivings as to the wisdom of a change in the existing organisation. The subject was treated with the utmost frankness, and eventually, after proper safeguards to ensure the equality of meteorological services on technical matters had been provided, a World Meteorological Convention was drafted and signed by thirty-three countries. It will come into force on ratification by thirty countries, and the World Meteorological Organisation will take over the assets and obligations of the existing International Meteorological Organisation, which will cease to exist.

A decision to seek affiliation to the United Nations was quickly reached once the subject of the Convention had been settled. With the assistance of delegates from the United Nations who were present at the Conference, a draft agreement was drawn up which, after approval by a majority of members of the International Meteorological Organisation, will be submitted to the United Nations. If this is accepted, the World Meteorological Organisation will be linked with the United Nations as a specialized agency.

On the technical side, the Conference approved more than two hundred resolutions of the technical commissions, and formed two new commissions, one to study radio-electric meteorology and the other to deal with problems of Arctic and Antarctic meteorology. At two sessions, which were attended by delegates from the International Civil Aviation Organisation, measures designed to co-ordinate the activities of the two Organisations in meteorological affairs were agreed.

The Toronto and Washington meetings, considered either separately or as a whole, were most successful, and well repaid the sustained effort that was required from the delegates. Considerable progress was made both on the technical side and in improving the machinery for applying meteorology to human welfare. One of the most important results was, of course, the signing of the World Meteorological Convention. This decision to effect a fundamental change in the status of the International Meteorological Organisation illustrates the determination of members to adapt the Organisation to modern world conditions. Another promising feature was the emphasis placed upon research, and at the meetings of the technical commissions it was gratifying to notice that the delegates included a high proportion of younger men of science of great ability and originality of outlook.

THE TEAK FORESTS OF BURMA

By Prof. E. P. STEBBING
University of Edinburgh

THERE is probably more romance wrapped up in the history of the great teak forests of Burma, without the addition of the latest war chapter of the Fourteenth Army, than in any other afforested region of similar size in the world. To a large extent the teak tree is itself responsible. Our acquaintance with these forests, so far as the British personally are concerned, commenced with the inquiries into their resources made by the Government after the acquisition for political reasons of the Tenasserim and Martaban Provinces, ceded to the British by Burmese under the Treaty of Yandaboo early in the year 1826. Although the British in India and the Admiralty at home had obtained a certain amount of teak from Rangoon and Moulmein, the largest amount utilized up to this time came from the accessible parts of the teak forests in Malabar on the west coast of Madras. These, in the hands of timber exploiters, were to a great extent cut out by 1830.

Dr. Wallich, superintendent of the Botanic Gardens, Calcutta, was sent to the new Province to report on the botanical features of the forests, and also on their potential possibilities both commercially and for the provision of teak timber required for military purposes. There were great stores of teak in the forests, he said. He advised, in view of the destruction caused in the Malabar forests by unchecked exploitation, that Government should declare its ownership of all teak and that the forests should be managed by Government so as to ensure against their ruin. He added, "No forest exists which can, with propriety, be called inexhaustible—at least none that is liable to constant and extensive demands for timber". The advice was not adopted by the commissioner-in-charge of the new Province. A system of leases was instituted under which the lessee was allowed to take up a block of forest on one or other of the rivers and operate as he liked; the few rules issued were generally disregarded. Moulmein, from little more than a large village, soon became an important town, and within twenty years the whole of the population were immersed in the teak industry to the neglect of any attempt at an improved and extended area under agriculture. A score of years after the annexation, the greater part of the accessible forests had been treated in a fashion similar to the Malabar ones.

The licence method had proved to be a difficult one to supervise and, in the late forties, the Deputy Governor suggested to the Court of Directors that long 99-year leases should be given out in order to interest the licensees in growing teak, a long-term project. Later he earnestly recommended the Court of Directors to give authority to sell the whole of the teak forest lands in tracts of convenient extent and to convey to the purchasers a complete title. The Court of Directors was mercifully too wide-visioned to adopt this suggestion.

The Second Burmese War took place in 1852, the outcome being the annexation of the Province of Pegu on December 20, 1852. Rangoon was the capital, having been founded by the Alompra dynasty in 1775. It had been the principal mart for the export of teak timber for nearly a century, teak being the chief staple industry of the port at that time. The teak tree had been proclaimed a royal tree by this dynasty, and was a royal monopoly, as had been the case with Tippoo Sahib in Southern India, and in the neighbouring Travancore and Cochin States. Following this precedent, soon after the annexation a notification was issued by the Governor-General that all the forests were the property of Government and no general permission to cut timber therein would be granted to anyone. But differences of opinion soon arose between the commissioner appointed to administer the Province and the forest officer. The Governor-General had proclaimed the teak public property, but both the above officials agreed that the Tenasserim royalty of 15 per cent only should be levied on all timber brought down river to Rangoon. The differences between them were on other issues. This led to the famous minute from the Governor-General, Lord Dalhousie, which has been termed "The Charter of the India and Burma Forests". In this he directed attention to his former notification on the ownership of teak, which laid down that the teak timber should be retained as State property. In effect, Lord Dalhousie laid down that the forests were the property of the State, which meant of the public, and that the material in them should be sold at a price the market was prepared to pay—that the system by which the timber merchant made the greatest profit must cease. In the past, big timber firms had been in the habit of getting a permit to take up blocks of teak forest and work them out for teak, paying the Crown a lump sum down and an agreed price per tree or log extracted. The profits, as in the case in Moulmein, of the timber speculators had been excessive, while the activities of the whole people were confined to one business, to the detriment of agriculture.

Lord Dalhousie found a man in Dr. (later Sir Dietrich) Brandis to give effect to his proclaimed policy. Brandis was appointed superintendent of the Pegu Forests in January, 1856, and shortly after to those of Tenasserim. The first step was to put an end to indiscriminate felling in the forests by obtaining some figure of their volume-value in teak, to enable him to prescribe the volume per unit of area which could be safely cut without overfelling in the forest. He instituted his now well-known 'strip surveys'—marching through the forests on a line previously laid down and measuring up on either side all teak trees on a 50 ft. strip. He made four girth classes: 6 ft. and more; 4 ft. 6 in. to 6 ft.; 3 ft. to 4 ft. 6 in.; less than 3 ft. An area of 30 square miles was covered by these linear surveys, on which 2,423 trees of 6 ft. and more had been counted, or an average of eighty trees per square mile. It was estimated that the teak in Pegu was scattered over an area of 7,000 square miles, giving a grand total of 385,000 first-class trees of 6 ft. and more. On this he based the number of trees he could mark for sale each year. The danger of ignorant over-felling was past. The teak had to be girdled when marked and stand in the forests for two to three years to dry; since green teak will not float, and much of the teak was transported from the forest to the market at Rangoon by floating down the rivers. Later calculations of the volumes of teak in the forests made by a more numerous staff proved that Brandis' figures were extraordinarily accurate, considering the rough methods he had to use.

Brandis considered that Government must show the way and prove that the forests could be worked efficiently, the trees felled and logs extracted with the minimum of damage, while, at the same time, the prices received for the timber would repay all charges of felling and extraction and show a handsome surplus. Brandis started work, hiring contractors to fell the timber, drag it to the floating streams and raft it to the sale depots. Local contractors and others more powerful at a distance put every obstacle in the way of the new departure, and it took a man of Brandis' forceful nature to fight and live down this concentrated opposition. The Government was by no means convinced as to the soundness of Brandis' proposition. In its view the first necessity was to ensure that the annual amount of teak timber required by the Government services was forthcoming without any danger of deficiencies: the second that in the first few years working the costs were larger than the receipts. The powerful timber contractors carried the matter to the Privy Council; but the Government's view was upheld in its main contention—that the teak forests were public ownership and should not be worked unchecked by timber exploiters. Brandis soon saw that it would be impossible to work such large areas departmentally, owing to the want of staff and other reasons. He therefore suggested that 12–15 year leases should be granted to approved timber contractors for a definite forest area, the trees to be removed to be marked and girdled by the Forest Department, and the lease be subject to certain definite conditions as regards methods of felling, extraction, etc. This practice is still in force. The other directions in which a true forest administration was commenced in Burma are by now well known. In 1861 Brandis was transferred to India and appointed first inspector-general of forests to the Government of India, and in 1864 the Indian (including Burma) Forest Service was formed, to be officered by men trained in Europe.

The Third Burma War and the annexation of Upper Burma might be said to have witnessed the third advance in forestry progress in Burma. The political reasons are not under consideration. The proclamation of the annexation of Upper Burma in January 1886 was made just sixty years after the annexation of Tenasserim. The new territory placed an enormous area of potential teak and other forests under the Forest Department, the staff of which was far too small to deal with the task. However, progress was made in a remarkably short time by transferring some officers from India.

Once again, and for the last time, the big timber contractors sought to get a free hand in the exploitation of the teak forests in this new Province. Once again the fight was carried to the Privy Council.

But the Inspector-General of the day, Ribbentrop, who had had long experience in Burma as a forest officer, won his case: and all the more easily since it was possible to point to the Pegu Forests thirty years after Brandis had stopped unchecked fellings, and compare them with the position of the cut-out Malabar Forests in 1830 and Tenasserim in 1845.

The reservation of the forests went steadily forward during the last thirty years of the century. Another matter, first enunciated by Brandis, but not actually put into practice by him, was to make use of the nomadic shifting cultivation habits of the Shans and Karens by getting them to sow teak seed or plant in teak plants with their (shifting) cultivation. The idea was not new: both in France and Germany the practice had been in force in the past. In Burma the term 'taungya' had been given to the method, from the Burmese word for shifting cultivation. Considerable patches of young teak poles existed at the end of the century about the country, but as no record or map had been kept they had mostly been lost to sight in the encompassing forest. In the early years of the present century the method fell into abeyance, but was revived at Tharrawaddy during the second decade of the century with very great success. This practice was adopted in the case of *sal* in Bengal and spread throughout India and out to Africa and other parts of the Empire. I saw it in practice by the French forest officers in the Ivory Coast in 1934, copied from the work of British officers in Nigeria.

Forest administration based on sound sylvicultural management and finance made great progress in Burma during the first two decades of the present century. The First World War proved the soundness of the foundations laid. Great demands were made upon Burma to supply the requirements in Mesopotamia, and several other species besides the now commonly used ones, teak and pyinkado, were utilized, some remaining on the market afterwards.

Since the first successful attempt at protecting an Indian teak forest from fire (in the Central Provinces) during the hot-weather season in India had passed successfully, a fire protection system had been devised for all the reserved forests in India and Burma. Fires occurred annually; but the wholesale scale of former times had come to an end. At the beginning of the present century fire protection in the moist teak forests in Burma was called in question. It was found that a low growth of evergreen shrubs covered the forest floor, through which no teak seedling could penetrate. Careful examination showed this to be true in both the moist teak and moist *sal* areas (in India). Fire protection was, therefore, given up save in the very young new woods. As an outcome, a practice termed 'early burning' was adopted, with good results.

To the trained and experienced forest officer, the test of the efficiency, thoroughness and permanency of a forest administration can be studied in one way and one way only—by the presence of working plans in the area of forest administered, the degree of intensity on which the working plans are drawn, and the manner in which they are worked. A forest under a well-drafted working plan, which has passed the scrutiny of the higher forest authority, and been sanctioned by the civil administration of the country, is as safe as man can make it. Such plans laying down the whole management of the forest are usually drawn up for ten-year periods. Burma holds a high place in this important practice of the correct administration of a forest. It is understood that no serious damage to the teak forests was done during the Second World War. Teak is chiefly a timber felled for export. During the War, all teak exports ceased and the Japanese did not undertake any serious fellings in the teak areas, only cutting what they required for their military forces. In 1939 it may be said that Burma could show as fine a series of working plans for great forests from, to quote examples, the plans for South Toungoo and Tavoy in Tenasserim, South Pegu, Zigon and the Northern Shan States, to the Mu and Katha Forests and those of the Chindwin in the north. The work is not finished. For example, some of these working plans have been revised or re-written several times since the early days of the first real working plan (omitting the 'paper' or purely volume statistic plans of Brandis' day) of the early 'eighties. Others are first plans, as, for example, the Mu working plan drawn up for the period 1929–30 to 1938–39.

The total area of the Government reserved forests in Burma in 1938–39 on March 31, 1939, was 20,100,221 acres. The total volume of teak timber felled during 1938–39 was 1,402,548 cubic feet. The total volume of teak timber exported in 1938–39 was as follows in cubic tons: teakwood, 203,596; teak sleepers, 609; teak squares, 59,385; teak conversions, 137,401; teak round logs, 6,209; total, 407,200 cubic tons; teak keys (in tons), 4,753.

That long role of British forest officers which commenced with Brandis more than ninety years ago is now to terminate. They have done a magnificent work for Burma, and have left a great heritage to the Burmans. The latter are now going to take full control of this finely tempered forest administration and these enormously valuable forest estates. In bidding a farewell we can but wish them all success, coupled with the warning that there is no other property in the world which can be so insidiously depreciated, since it inevitably takes a term of years before the effects are perceivable or can be appreciated.

OBITUARIES

Dr. Cyril Strickland

Dr. Cyril Strickland, who died on November 3 in Jersey, aged sixty-six, was born in Cape Colony. He was educated at St. Andrew's College, Grahamstown, and at Oundle School.

After graduating with first-class honours from Caius College, Cambridge, he went to St. Bartholomew's Hospital, London, but before completing his medical course he accepted an invitation to study protozoology at Cambridge under Prof. G. H. F. Nuttall, whose assistant he became. During his tenure of this appointment he found time to take his degree in medicine. He also made the interesting and important discovery that the trypanosome of the rat was normally transmitted from rat to rat through the alimentary route by the mastication of infected fleas and not by the bites of the fleas as had previously been assumed.

In 1912 he went to Malaya to work on the malaria problem on behalf of the Government of the Federated Malay States.

Dr. (now Sir) Malcolm Watson had already been conspicuously successful in controlling by drainage the malaria of the flat coastland of Malaya; but the disease in the upland jungle remained a baffling problem. Strickland has described how, in the course of his work, he found that the jungle in Malaya remained free from malaria until clearing operations produced suitable conditions for the breeding of the vector mosquitoes. This discovery was published in a Government Paper in 1915; its importance was at once recognized, as was shown by the issue of an official prohibition of the clearing of jungle over collections of water without special permission. In India it was hailed as a "brilliant discovery".

In 1922 Strickland became the first professor of medical entomology at the recently established Calcutta School of Tropical Medicine and Hygiene, and during his seventeen years tenure of this post he was able to give a practical demonstration of the value of his discovery by enlisting the enthusiastic co-operation of the medical men, managers and agents of the tea gardens of Assam and north Bengal. The remarkable improvement in the health of the workers in these gardens is believed to have been due for the most part to the policy of maintaining a dense leafy shade over all waterways.

A problem closely studied by Strickland during his long period of fruitful work in teaching and research at Calcutta was the influence of land structure on malaria; he made a special study of the deltas of the Ganges and Brahmaputra and in 1939 published his "Deltaic Formation" (Longmans, Green and Co.). He hoped eventually to correlate the vast amount of data that he had collected regarding the incidence of malaria in eastern India with his survey of land formation, but he was unable to complete this study because of being compelled to retire in 1939 by the superannuation rules of Government. He was then employed by the Army in organising malaria work in Burma, where the campaign was already foreseen. He finally retired from active work in 1942.

WE regret to announce the following deaths:

Dr. Nicholas Murray Butler, for more than forty years president of Columbia University, aged eighty-five.

Mr. S. A. Courtauld, who built and endowed the Courtauld Institute of Biochemistry, and also endowed the professorship of anatomy at the Middlesex Hospital, on December 1.

Sir John Fraser, K.C.V.O., principal of the University of Edinburgh since 1944, on December 1, aged sixty-two.

Prof. Paul Monroe, professor emeritus of education in Teachers College, Columbia University, on December 6, aged seventy-nine.

NEWS and VIEWS

Presentation of Physical Society's Awards:

Charles Chree Medal and Prize

AT the science meeting of the Physical Society at the Science Museum on December 19, the Charles Chree Medal and Prize for 1947 will be presented to Sir Edward Appleton, who will then deliver an address entitled "Geomagnetism and the Ionosphere". Sir Edward has earned an international reputation for his work on the characteristics of the ionosphere, for which he was recently awarded the Nobel Prize for Physics for 1947 (see *Nature*, November 22, p. 703).

Charles Vernon Boys Prize

AT the same meeting the Charles Vernon Boys Prize for 1947 of the Physical Society will be awarded to Dr. C. F. Powell, reader in physics in the University of Bristol, for his development of the photographic-plate technique for the investigation of fundamental particles. Dr. Powell, who was born in 1903, carried out his first piece of research under C. T. R. Wilson at Cambridge on supersaturation in steam. In 1928 he became research assistant to Prof. A. M. Tyndall in the H. H. Wills Laboratory at Bristol, and in 1931 was appointed lecturer in physics there. His outstanding ability as an experimenter became evident in his systematic work on positive-ion emission in pure gases. Until a few years ago the Wilson cloud-chamber method was the only one used in the study of the tracks of high-speed particles, particularly if their energies were to be estimated. It occurred to Powell (and to others working independently of him) that it should be possible to make direct use of the photographic emulsion, in which the fundamental particles would have short ranges and the lengths and directions of the tracks could be measured after development of the plate. He originally used the method in the study of the processes occurring in cosmic rays. In 1938, with the aid of a Cockcroft 700-kV. generator which he had constructed at Bristol, he showed that quantitative information on nuclear processes could be obtained by this method. Since then, with the improved fine-grain emulsions produced by Ilford, Ltd., and with other facilities, he has established this technique as one of the most powerful instruments in nuclear study. It was by this technique that investigators in Joliot-Curie's laboratory discovered triple and quadruple fission in uranium nuclei. Powell himself has obtained range-energy curves for protons and other particles, and the recent discovery of new types of meson by Powell, Occhialini and Lattes has aroused world-wide interest. The presentation of the Charles Vernon Boys Prize will be followed by a brief address by Dr. Powell on the work which forms the basis of the award.

Centenary of the Exhibition of 1851

MR. HERBERT MORRISON, Lord President of the Council, announced in the House of Commons on December 5 that the centenary of the Great Exhibition of 1851 is to be marked by a comprehensive national display in addition to the annual British Industries Fair. It is proposed that the year 1951 should be marked by comprehensive and co-ordinated displays demonstrating British contributions to civilization, in the arts, in science and technology and in industrial design. The Central Office of Information, acting on behalf of the various research councils and other scientific bodies, is to be responsible for the presentation of science and technology. The Council of Industrial Design will take charge of an exhibition of consumer goods, civil transport, some handicraft production and displays showing the historical development of certain industries in Britain. The Arts Council of Great Britain is being asked to arrange, in association with other bodies, a Festival of the Arts, to include events in music and drama, opera and ballet, with exhibitions of painting, sculpture and photography. Arrangements will also be made to cover architecture, town-planning, books and films. No new building will, of course, be possible to accommodate the proposed displays and celebrations. Mr. Morrison emphasized that existing organisations would be invited to collaborate, and also that the provinces as well as London will be able to take a full part in the events, which will be spread over several months of 1951.

"Atomic Physics"

To attempt an intelligible outline of atomic physics on a film which takes about 1½ hours to show is no mean task ; this, however, is what G.-B. Instructional Ltd. have done in the film "Atomic Physics", and it can be said at once that it is done very well. Prof. G. I. Finch, of the Imperial College of Science and Technology, London, gave guidance during the early stages of production, and the advice of Dr. J. D. Cockcroft, Prof. R. E. Peierls and Prof. O. Frisch was obtained. Prof. A. Einstein, Dr. Cockcroft and Prof. Frisch recorded interviews which appear at appropriate places in the film. In addition, the producers were given facilities to use historical apparatus and to photograph modern research equipment to illustrate the development of the theme; among those contributing in this way are mentioned the Royal Society, Royal Institution, Science Museum, Cavendish Laboratory, Imperial College, Research Laboratories of the G.E.C. (England), Messrs. Kodak and Cinema Television. Extracts of films of J. J. Thomson speaking on the electron, and of Lord Rutherford speaking on atomic structure, are included. The Atomic Scientists' Association arranged for one of its members to give technical guidance throughout the film.

The film is arranged in five parts, which can be shown separately. Part 1 is entitled "The Atomic Theory" and illustrates the developments of the nineteenth century, touching on Dalton's work, Faraday on electrolysis, and Mendeléeff's periodic table, and illustrating the current views on molecules and atoms. Part 2 is concerned with "Rays from Atoms" and deals mainly with J. J. Thomson's work. Part 3, on "Nuclear Structure of the Atom", reconstructs the work of Becquerel and the Curies, and is dominated by Rutherford. Part 4, on "Atom Smashing", carries the story up to the work of Cockcroft and Walton, giving also an account of Sir James Chadwick's discovery of the neutron; modern research equipment is illustrated in this part of the film. Part 5, "Uranium Fission", requires little explanation; the atom bomb is dealt with and an idea given of some of the present aims of peace-time research on atomic fission, with a solemn warning of the dangers to mankind if international control of atomic energy is not achieved. Throughout the film, skilful use is made of animated diagrams to demonstrate the mode of action of experimental equipment; this is done by superimposing diagrams upon, and displacing, photographs of the apparatus. The theoretical discussions are also shown diagrammatically. The commentary is brief and to the point; with the recorded interviews, it completes a very able historical survey of the basis, present position and significance of atomic physics.

International Collection of Pure Chemical Substances

At the request of the United Nations Educational, Scientific and Cultural Organisation, and by agreement with the International Union of Chemistry, the International Bureau of Physico-Chemical Standards of Brussels has accepted the task of establishing a collection of pure chemical substances of every kind (metals, alloys, mineral and organic substances, plastics, samples of biological interest, etc.), to place them at the disposal of the laboratories and research workers of all countries, so as to enable them to control the nature and the purity of their own samples, or for any other research work. The expenses of the scheme, including distribution of the samples, will be met by a subsidy from U.N.E.S.C.O. An appeal is therefore being made to all laboratories and research chemists who have prepared, or have at their disposal, such substances in a state of sufficient purity, to send a sample to the new centre with a concise note showing its method of preparation and purification, and its principal constants. If a sample cannot be provided, a description with its constants might be sent, so as to enable the Bureau to establish a register of such substances. It is emphasized that this scheme is not intended to compete in any way with chemical industry, and that products easily obtainable on the market fall outside its scope. Research laboratories of the chemical industries, which often possess samples of rare substances, prepared for their own use in small quantities, and not included in the catalogues of industrial and commercial firms, are invited to co-operate. No samples should be sent without communicating first with the Bureau. Detailed information about the scheme can be obtained from the director of the International Bureau of Physico-Chemical Standards, Prof. J. Timmermans, Université Libre de Bruxelles, 50 Avenue Franklin Roosevelt, Bruxelles, Belgium.

Southwest Research Institute of San Antonio, Texas

The Southwest Research Institute, a non-profit scientific organisation for technological research in support of industry in the south-western United States, was opened in September. Mr. Tom Slick, who is closely connected with oil development and ranching in San Antonio, has given an endowment of more than 1,000,000 dollars. The Institute follows the pattern of the Midwest, Armour and Mellon Institutes in that it will conduct industrial research on a fee basis ; under its charter, sponsoring manufacturers or trade associations retain patent rights on all discoveries accruing from research projects. The dedication ceremonies, at which Mr. Slick was present, took place in the historic old Cable Ranch House, when speakers pointed out that the Southwest Research Institute would provide facilities to the rapidly expanding industrial interests of the south-western States similar to those enjoyed by industry in the north and east. The Institute is the first of a series ; the next is to be built in Houston and devoted entirely to petroleum technology ; an office in the Oil and Gas Building has already been staffed to provide consultation services for manufacturers and processors in the area. The present staff of the Southwest Research Institute includes W. M. Hammond, acting director and business manager, formerly business manager for the Armour Foundation ; Dr. H. C. Dyme, chemist and bacteriologist; Dr. John B. Loefer, biologist and authority on micro-organisms; Robinson Brown, mechanical engineer and oil equipment expert; Dr. Judson Swearingen, chemical engineer and authority on high-pressure processing, blowers and turbines; Dr. Paul A. Keesee, veterinarian known for his work in artificial insemination; Dr. F. W. Bieberdorf, botanist and authority on plant pathology; Mr. I. O. Gilbert, specialist in electronics and machine design.

The first laboratory of the Southwest Research Institute, functionally designed and equipped with modern instruments and machines, houses chemical and biological laboratories, engineering department, a complete machine shop with foundry, forge, tin shop, welding and heat-treating equipment, an animal room as part of the biological section, and various cold rooms, sustained humidity rooms, a self-contained power plant, distillation plant, and other scientific facilities. A separate, underground vault for storage of volatile chemicals is located near by. The Institute is the third and largest unit affiliated with the Foundation of Applied Research, an earlier organisation established by Mr. Slick and other trustees. The first unit of the Foundation is Essar Ranch, widely known for its pure-bred Hereford and Aberdeen-Angus cattle, its experimental cross-breeding of Angus and Brahman strains to produce a hardy beef cattle for tropical regions, and artificial insemination experiments. The second is the Institute of Inventive Research, which provides inventors with a complete processing service without cost.

Coconut Conference

BECAUSE of the present world shortage of vegetable oils and fats, and the fact that the situation is one which will take years to remedy, particular interest is attached to the oil-producing crops, their cultivation, conservation, potentialities and use. During the summer the Coconut Conference (Colombo, July 4, 1947) covered much useful ground, papers, chiefly of a directly practical nature, being devoted to the regeneration of plantations, the use of manures, the value of combining animal husbandry with coconut cultivation, problems of soil conservation, the control of insect pests, and problems of co-operation and marketing of coconut products. This report will undoubtedly prove of interest and value to scientific workers and members of the planting community in other tropical regions where the coconut is an important crop.

Marriage Hygiene

Marriage Hygiene, a quarterly journal published before the War, has been revived. The second series commenced with the issue of August 1947. The managing editor, Dr. A. P. Pillay, is an Indian. He is supported by a staff of editors representing Australia, Britain, China, Europe, the Far East, the Middle East, South Africa, South America, and the United States. It is therefore an international production. The British editor is Dr. Norman Haire, and the distribution in Britain is in the hands of H. K. Lewis and Co., Ltd., 136 Gower Street, London, W.C.1. The annual subscription is 22*s*. The August issue comprises sixty-four pages of articles, notes and comments, reviews and the like. An examination of this material shows that it is a journal of sexology rather than of marriage. Some of the subjects discussed are frigidity, sterility tests, incest, male sexual disorders, transvestism, and necrology. Such a journal, treating sexual phenomena with scientific detachment and in uninhibited detail, should serve a useful purpose in providing a forum for free discussion and the interchange of clinical data. It is to be hoped, however, that the title will be changed to place the emphasis where it properly belongs—upon sex rather than marriage.

Cosmic Rays and Cancer

Sky and Telescope of July has an article with this title, which describes the experiments of Dr. Frank H. J. Figge, of the University of Maryland Medical School, on mice. Male mice were injected with the cancer-inducing substance, methylcholanthrene, and were then distributed in eight cages, five of which were covered with quarter-inch plates of lead. When cosmic rays pass through thin sheets of lead, showers are produced, thus intensifying the effects of cosmic radiation; and the cages were so arranged that various groups of mice were differently exposed to the scattered cosmic radiation during the five months of experimentation. Those so exposed developed tumours in an average period of 8·5 weeks, while 11 weeks were required for those exposed to normal cosmic rays. Other experiments showed the greater susceptibility of mice exposed to cosmic-ray showers. It is true that direct radiation is less effective than secondary showers; but its effect over a life-time seems to be cumulative. Perhaps architects of the future may be called upon to assist in arresting the development of cancer by choosing building materials which will minimize the effect of cosmic-ray showers.

Library of the History of Medicine, Yale

THE report for the year 1946–47 of the Historical Library of Yale University School of Medicine records the safe receipt, with only one damaged volume, of the Klebs Library from Geneva, where it was packed and stored in 1943 by the deputy librarian of the United Nations Library. The report also records the circumstances in which Dr. Henry Sigerist resigned in 1947 the chair of the History of Medicine in Johns Hopkins University, a chair which he had held for fifteen years, in order to devote himself to his eight-volume history of medicine. This great act of devotion to scholarship has been facilitated by the appointment of Dr. Sigerist as a professorial research associate of Yale University, with affiliation to the Historical Library of the School of Medicine. This appointment will enable him to continue his historical work at Pura, near Lugano. The first volume of his history of medicine is now nearing completion and will be published by the Oxford University Press.

Fitzwilliam Museum, Cambridge

THE annual report of the Fitzwilliam Museum, Cambridge, for the year ending December 31, 1946, has been issued. It is the last report with which Mr. Louis Clarke, to whom the Museum is so much indebted, is concerned. His successor, Mr. Carl Winter, formerly deputy-keeper of the Department of Paintings in the Victoria and Albert Museum, London, is now in charge. The report follows the usual lines, and a number of important gifts and acquisitions have been received. Outstanding is Mr. Raphael's great, green jade recumbent buffalo (Han dynasty), which weighs no less than 56 lb. But there are also many other valuable additions to the collections in all the various departments.

Acta Hydrobiologica et Protistologica

A NEW international review on hydrobiology and protistology is to appear shortly, under the above title. The board of editors comprises Dr. G. Alm (Sweden), Prof. H. d'Ancona (Italy), Prof. K. Berg (Denmark), Prof. F. E. Fritsch (Great Britain), Prof. K. Münster Ström (Norway), Prof. William R. Taylor (United States), Mrs. N. Wibaut-Isebree Moens (Holland), Prof. P. van Oye (Belgium), managing secretary. Some seventy leading scientific workers from most countries of the world have promised to support the new periodical, which is intended not only for the publication of original papers on all branches of hydrobiology and protistology, but also for reviews of books and papers, information on scientific institutes, along with a personal section, correspondence, etc. The review is to appear in four quarterly issues of about 100 pages each; the price of each volume of four issues will be 40 guilders. Subscriptions should be sent to A. Oosthoek's Uitgevers Mij, Domstraat 1–3, Utrecht, Holland.

Britain in 1955

"BRITAIN IN 1955" is the theme of a special issue of *Future*, skilfully and collectively produced by a group of experts. The 'high light' is an economic analysis, from the vantage point of 1955, of the preceding decade; but other articles, particularly on the agricultural revolution, industrial relations, the universities, and meteorology, are also most stimulating. In effect, the future is foreshadowed by an informed examination, on specified assumptions, of current trends. A synoptic approach is adopted throughout. There are touches of "The Shape of Things to Come", "Erewhon", and "Brave New World" in judicious combination. An unreal element is the apparent disappearance of serious political controversy. Is this wishful thinking?

U.S. National Research Council Fellowships

THE U.S. National Research Council is again offering a number of fellowships for advanced study and research in the natural sciences. The post-doctoral fellowship programme, administered by the Council for the past twenty-eight years and financed by grants from the Rockefeller Foundation, is designed to permit young men and women who have demonstrated their ability in research in the natural sciences to spend additional time in uninterrupted study. Stipends are at the rate of 2,500 dollars a year, plus travel to the place of study. Since the War, Merck and Co. has supported a fellowship programme in the chemical and biological sciences, designed to stimulate interest in fields of study requiring knowledge of more than one science. These fellowships are therefore designed to give special training to young men and women who have demonstrated marked ability in research in chemical or biological science and who wish to broaden their fields of investigational activity. The annual stipends are in the range 2,500–5,000 dollars, with an allowance of 500 dollars a year to the institution to which each fellow is assigned. A third programme recently inaugurated by the Radio Corporation of America is designed to give special training and experience to young men and women who have demonstrated marked ability in the general field of electronics. Their preliminary experience may have been either in the fields of electrical engineering or physics. Applicants need not have completed more than one year of graduate work, and they must be United States citizens. The fields of study to be undertaken are in the sciences underlying the general science of electronics. Stipends range from 1,600 to 2,100 dollars a year. Further particulars of all these fellowships can be obtained from the National Research Council Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C.

University of London: Appointments

THE following appointments in the University of London have been announced: Mr. W. D. Hogarth to be clerk of the University Court as from January 1 in succession to Dr. D. W. Logan, who becomes principal of the University on that date; Dr. L. P. Mair to the University readership in Colonial administration tenable at the London School of Economics and Political Science as from October 1, 1947; Dr. N. F. Maclagan to the University chair of chemical pathology tenable at Westminster Hospital Medical School as from October 1, 1947.

The degree of doctor of science has been conferred on Conrad Ellenby, of University College, and on G. M. Dyson, an external student.

The Botanical Society of the British Isles

THE name of the Botanical Society and Exchange Club of the British Isles has been changed to the Botanical Society of the British Isles. New and extended facilities are being offered to members, including the privilege of consulting a panel of specialists. A Conference on "The Study of Critical British Groups" is being arranged in London during April 9–10, 1948. All inquiries should be addressed to the honorary general secretary, Miss M. S. Campbell, c/o Department of Botany, British Museum (Natural History), Cromwell Road, London, S.W.7.

Commonwealth Agricultural Bureaux

THE Executive Council of the Imperial Agricultural Bureaux has decided to change the name of the Bureaux as from January 1 to Commonwealth Agricultural Bureaux. The Bureaux will continue as hitherto in control of the Institute of Entomology, the Mycological Institute, the Bureaux of Soil Science, Animal Health, Animal Nutrition, Plant Breeding and Genetics, Pastures and Field Crops, Horticulture and Plantation Crops, Animal Breeding and Genetics, Agricultural Parasitology (Helminthology), Forestry, Dairy Science, Biological Control and the South American Potato Collection.

Announcements

THE Medical Research Council has recently reconstituted the Dental Research Committee, the function of which is to advise and assist them in the promotion of scientific investigations in this field. The secretary of the Committee is Prof. M. A. Rushton, Department of Dental Medicine, Guy's Hospital, London, S.E.1.

A SERIES of three Christmas Lectures for Boys, on "High-Speed Flying and the Airport", has been arranged by the Institution of Civil Engineers. They will be given by Group Captain E. M. Donaldson, C. E. Foster, and Air Marshal Sir John D'Albiac, on December 30, January 2 and 6, at 3 p.m. Tickets, which are free, can be obtained from the Secretary, Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Chlorocruorin and Hæmoglobin

THERE are four respiratory pigments which circulate in the blood or are found in the body cavity of animals. Two of these, the red hæmoglobin and the dichroic red-green chlorocruorin, are close chemical relatives. Chlorocruorin is confined to certain marine polychæte worms and is characteristic of the group Serpulimorpha, comprising the families Serpulidæ and Sabellidæ. Hitherto it has been thought that all species in this group possess chlorocruorin in their blood. This, however, is not the case. I have found chlorocruorin in twenty-one species of the group, belonging to fifteen genera. One of the species with chlorocruorin is *Spirorbis borealis* Daudin, but another species of the same genus, namely, *S. corrugatus* (Montagu), has hæmoglobin as its blood pigment. Yet another species, *S. militaris* (Claparède), has neither pigment: its blood is colourless. That chlorocruorin and hæmoglobin are really absent here, not just dilute, is proved by the fact discovered by my colleague, Miss Jean Hanson, that the benzidine reaction is negative in the blood vessels of *S. militaris*. These several species of *Spirorbis* live in similar situations, so that the possession of either or neither respiratory pigment appears to be functionally unimportant.

In *Serpula* the blood contains both chlorocruorin and hæmoglobin. It is greenish-brown in colour and has three strong absorption bands in the visible region of the spectrum, namely, the α-band of oxychlorocruorin and the α- and β-bands of oxyhæmoglobin. MacMunn[1] saw this spectrum, but did not recognize the hæmoglobin. Thus for the first time two respiratory pigments have been found in one blood. This duplicity is characteristic of the genus *Serpula*, for it occurs in both the species which I have been able to examine, namely, *S. vermicularis* L. and *S. lobiancoi* Rioja. We have here a chemical generic character that will have to be taken into account by taxonomists; it is comparable with chemical specific characters which the respiratory pigments have already furnished[2].

In one genus only of the Serpulimorpha have I found a respiratory pigment in tissue cells: *Potamilla*, with only chlorocruorin in the blood, has hæmoglobin in its muscles. Just as in the case of mammalian myoglobin, the wave-length of the α-band axis of the hæmoglobin in *Potamilla* muscle is longer than that of the mammalian blood pigment. The muscles of *P. reniformis* (O. F. Müller) are pink with hæmoglobin, whereas those of *P. stichophthalmos* (Grube) have just a little of the pigment. As the two species live side by side in the same stones, again the pigment difference does not seem functional.

The hæm of chlorocruorin is spectroscopically different from protohæm, the hæm of hæmoglobin[3]. Most animal cells contain protohæm[4], whether or not the animals possess hæmoglobin. It is therefore of particular interest to know if animals with chlorocruorin in their blood have protohæm or chlorocruorohæm in the cells of the various tissues of the body. I have studied this question in the Serpulimorpha, particularly in the largest member of the group, *Sabella spallanzanii* (Viviani), previously known as *Spirographis*[5]. By adding pyridine and measuring the hæmochromogen α-band I find that protohæm alone is present in the tissues; it is found in muscles, tube-forming glands, gut wall, nephridia, eggs and sperm. Chlorocruorin, which is in solution in the blood, has never been found in a cell, and its hæm, too, is absent from the cells of Serpulimorpha. Evidently chlorocruorohæm must be formed from protohæm somewhere in the blood system. This conversion has been accomplished *in vitro*[6]. Chemically it is not a big change: one of the two vinyl groups attached to the 4-pyrrol ring of protohæm is oxidized to a formyl group[7]. Cytochrome is widespread in animals[8], and since the hæms of cytochrome *a*[9] and of cytochrome oxidase[6] are very close to chlorocruorohæm, a similar oxidation of the all-pervading protohæm may take place in many animal cells. Incidentally, in the Serpulimorpha I have found no cytochrome.

In the lumen of the gut of serpulids there is a pigment in solution which has a protohæmochromogen spectrum. It recalls helicorubin in snails, and the gut hæmochromogen of *Daphnia*[10]. Presumably it is derived from the protohæm compound in serpulid tissues. What, then, if any, is the breakdown product of chlorocruorin in the blood? Is the chlorocruorohæm again reduced to protohæm, to swell the gut hæmochromogen?

Protohæm is also present in the mucoprotein tube of *Sabella* and in the membranous lining of the calcareous tube of *Protula*. This recalls the presence of chlorocruorin in the mucous jelly tube of Myxicola[3]. What other cases, except pathological ones, are known of the excretion, either into the gut or in skin secretions, of hæm compounds as such—that is to say, not broken down to bile pigments or porphyrins?

A full account of this work, most of which was done at the Zoological Station of Naples, will be published soon.

H. MUNRO FOX

Bedford College,
University of London.

Sept. 24.

[1] MacMunn, C. A., *Quart. J. Micr. Sci.*, **25**, 469 (1885).

[2] Fox, H. Munro, *Nature*, **157**, 511 (1946).

[3] Fox, H. Munro, *Proc. Roy. Soc.*, B, **99**, 199 (1926).

[4] Keilin, D., *Proc. Roy. Soc.*, B, **104**, 206 (1929).

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[7] Fischer, H., and Seemann, C. V., *Hoppe-Seyl. Z.*, **242**, 133 (1936).

[8] Keilin, D., *Proc. Roy. Soc.*, B, **98**, 312 (1925).

[9] Keilin, D., *Ergebn. Enzymforsch.*, **2**, 239 (1933).

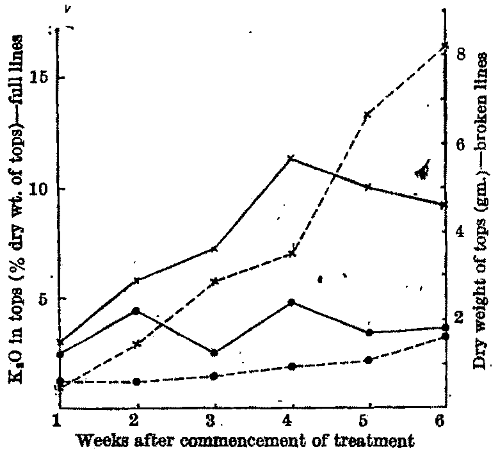
[10] Fox, H. Munro, *Nature*, **160**, 431 (1947).

Effect of 4-Chloro-2-Methyl Phenoxyacetic Acid on the Mineral Content and Growth of Plants

Templeman and Sexton[1] have shown that certain concentrations of the aryloxyacetic acids produce a differential effect on the growth of plants of different species. This effect, very marked in the case of 4-chloro-2-methyl phenoxyacetic acid, has now been utilized as a means of eliminating weeds from cereal crops.

We began a study of the mode of action of 4-chloro-2-methyl phenoxyacetic acid on plant growth in 1946. As a result of field experience, rape and spring oats were selected as examples of susceptible and resistant crops, and corn chamomile for intermediate response. Seedlings of the three species were grown in small pots containing silver sand, surface-watered with 40 ml. of nutrient solution (*p*H 6) per pot, once or twice daily according to weather conditions. After three to four weeks, certain pots began to receive nutrient solution to which sodium 4-chloro-2-methyl phenoxyacetate had been added at various concentrations up to 0·5 parts per million, estimated to be the maximum concentration which the most susceptible species could survive. For the following six weeks a given number of pots from each treatment was withdrawn at weekly intervals for examination. The results were as follows.

(i) Rape (*Brassica campestris*). This species was highly susceptible. Chlorosis of the foliage, swelling of the hypocotyl and root tips, presence of adventitious roots and a less fibrous appearance of the roots were marked after only seven days treatment at 0·5 p.p.m. A similar effect was noticeable on the roots after thirty-five days with the concentration so low as 0·05 p.p.m. This was followed by a reduction in top growth (as evidenced by a comparison of the dry weights of treated and untreated plants), very marked at 0·5 p.p.m. and somewhat smaller at 0·1 p.p.m. The proportion of potassium in the tops, which in the untreated plants rose rapidly during the first four weeks under investigation and thereafter remained fairly constant (in spite of increasing dry weight), was restricted in the treated plants to little more than its original low level (see graph). The proportions of phosphorus and magnesium showed no corresponding diminution. The rate of root-growth (as evidenced by a comparison of the dry weights of treated and untreated plants) was not reduced, despite the early change in the character of the roots, until a later stage of development, and even then the effect was small.



CHANGES IN DRY WEIGHT AND K_2O CONTENT OF TOPS WITH TIME IN RAPE PLANTS TREATED WITH SODIUM 4-CHLORO-2-METHYL PHENOXYACETATE AT 0·5 p.p.m.

×——×, K_2O content of control
●——●, „ after treatment
×- - - -×, dry weight of control
●- - - -●, „ after treatment

(ii) Corn Chamomile (*Anthemis arvensis*). This species was moderately susceptible. Characteristic changes in the morphology of the roots and hypocotyl appeared after seventeen days of treatment at 0·5 p.p.m. This was followed by a reduction in top growth (not so marked as in rape) at 0·5 p.p.m., but was scarcely appreciable at lower concentrations. The proportion of potassium in the tops of both treated and untreated plants showed no marked differences (the plants treated at 0·5 p.p.m. gave some indication of a lower proportion of potassium), only falling slightly during the experiment in spite of a 27-fold increase in dry weight. There were no marked differences in the proportions of phosphorus and magnesium and the rate of root-growth was unaffected.

(iii) Spring Oats (Variety "Victory"). This species was most resistant. The roots were unaffected until 28 days after commencement of the 0·5 p.p.m. treatment, and subsequent diminution of top growth was quite negligible. Despite a tenfold increase in dry weight during the period of the experiment, the proportion of potassium in the tops of both treated and untreated plants remained roughly constant. The proportions of phosphorus and magnesium and the rate of root-growth were also unaffected.

Thus, the results show that the sodium salt of 4-chloro-2-methyl phenoxyacetic acid markedly interferes with the potassium metabolism of the most susceptible species. The nature of this interference[1] and its possible bearing on the causes of the selective phytocidal action are now being investigated.

A. RHODES
W. G. TEMPLEMAN
Imperial Chemical Industries, Ltd.,
Jealott's Hill Research Station,
Bracknell, Berks.
Aug. 29.

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[1] Templeman, W. G., and Sexton, W. A., *Proc. Roy. Soc.*, B, 133, 300 (1946).

Structure of Dimethylnitramine

ALTHOUGH they are of considerable interest from the point of view of valency theory, aliphatic nitro-compounds have hitherto been very little studied by X-ray analysis, and nitramines, so far as we are aware, not at all. We have now made a crystallographic study of dimethylnitramine and find that the molecule is flat with a considerable amount of double-bond character in the N—N bond.

Dimethylnitramine is monoclinic with $a = 6 \cdot 13$, $b = 6 \cdot 48$ and $c = 6 \cdot 08$ A.; $\beta = 114° 33'$. There are two molecules of $(CH_3)_2.N.NO_2$ in the unit cell (density 1·36 gm./cm.^{3}). The systematic absences of X-ray reflexions show that the space-group is either $P2_1$ or $P2_1/m$, and as the crystals show no pyro-electric effect the latter is more probable, so that the molecule probably possesses a plane of symmetry.

Examination of rotation and oscillation photographs about the b-axis shows that the sequence of intensities along the zero layer line (planes $h0l$) is exactly paralleled by the sequence along the second layer line (planes $h2l$), while the intensities on the first and third layer lines also agree in every detail. This result can only be explained on the supposition that all the atoms lie in two parallel planes $\frac{1}{2}b$ (that is, 3·24 A.) apart, and this can only be so if the molecules are completely flat. More detailed study of the intensities gives no evidence of the smallest deviation of any atom from the one plane; and it seems reasonably certain that all the atoms of the molecules (other than hydrogen, which are presumably distributed statistically) lie on planes of symmetry parallel to (010) in accordance with one of the two alternatives permitted by the space-group $P2_1/m$. It may be noted that the optical properties agree with this conclusion, the minimum index (1·41) being parallel to the b-axis.

If the N—N bond were single, it would be expected that the three bonds N—N, N—C_1 and N—C_2 would be disposed approximately tetrahedrally and certainly not in a plane. The foregoing result therefore suggests that the N—N bond possesses a certain amount of double-bond character, and this is supported by the inter-atomic distances which we have obtained. A large number of X-ray reflexion intensities have been measured, and preliminary Fourier syntheses carried out; the bond-lengths derived from them (all accurate to about ± 0·05 A.) are as follows:

N—O = 1·25, N—N = 1·26 and N—C = 1·46 A.

We prefer to postpone discussion of the theoretical significance of the results until further measurements have enabled us to improve the accuracy of the bond-length determinations; but we emphasize that the value of the N—N bond-length differs from the single bond-length by very much more than the experimental error.

This work was done in the Chemistry Department of the University of Birmingham during 1940–41, under a Ministry of Supply extra-mural contract, and while one of us (W. C.) was the holder of a Fenwick Scholarship and a Brotherton Scholarship; we are indebted to the Chief Scientist, Ministry of Supply, for permission to publish this note.

In the course of the work the numerous trial and error calculations which were necessary before syntheses could be carried out were much expedited by means of a special structure-factor calculating machine devised by one of us[1] and now being improved and rebuilt with the aid of a grant from the Royal Society.

Additional measurements on dimethylnitramine are now being made in order to determine the bond-lengths with the highest possible accuracy, and the work is being extended to compounds containing similar bonds.

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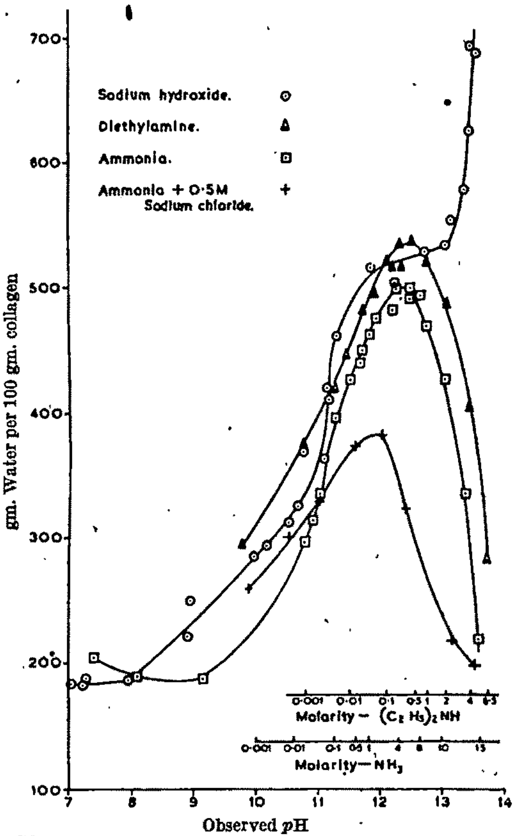
[1] Briefly described by E. G. Cox in the discussion on a paper by Beevers, C. A., *Proc. Phys. Soc.*, 51, 666 (1939).

Uptake of Water by Collagen in Solutions of Alkalis and Strong and Weak Organic Bases

The swelling of collagen and other structured proteins in solutions of strong acids takes place in accordance with the Donnan theory of membrane equilibrium[1,2,3]. Lyotropic effects of anions[4,5] and effects due to fixation of the anions by the protein[6,7,8] can also be observed.

At *p*H values below about 3·0, the water uptake is greater with weak than with strong acids, and the decrease at lower *p*H values is no longer apparent[3,9]; this effect may be attributed to the action of the undissociated acid on the cohesion of the protein[9,10].

We find that swelling in alkaline solutions at 20° is more complicated. With the strong bases sodium hydroxide and tetramethyl ammonium hydroxide, the water uptake of skin collagen does not decrease at high *p*H values as predicted by the Donnan theory, but after increasing less rapidly with rise in *p*H in the range 11·5–13, it increases again sharply as the *p*H is further increased (see graph). (It has been established that the guanidine groups in collagen do not begin to titrate below *p*H 13·5 and hence cannot be responsible for this increase in water uptake.) With the weak bases ammonia and diethylamine, the water uptake changes over the whole *p*H range covered in accordance with the Donnan theory. (The observed *p*H values plotted in the graph were determined using the special Beckman glass electrode; when the concentration of base is high and the activity of water is appreciably less than 1, the observed *p*H values will begin to differ from the true values[11].)



WATER UPTAKE OF SKIN COLLAGEN IN AQUEOUS SOLUTIONS OF ALKALIS AT 20° C.

These results cannot wholly be explained either on the basis of the Donnan theory, or of a specific cation effect. Although there is some indication that the sodium ion may have a specific effect in decreasing cohesion (see below), this effect is small compared with the effects now observed at high *p*H values; and the addition of sodium chloride does not alter the shape of the ammonia swelling-curve, but depresses the water uptake in accordance with the Donnan theory. It must be concluded, therefore, that the increased water uptake occurring at high values is associated with the presence of a high concentration of hydroxyl ions, which by some mechanism, probably breaking of hydrogen bonds, decreases the cohesion of the collagen and so allows it to take up more water. Since this effect is not operative with the weak bases, ammonia and diethylamine, it would appear possible that the presence of undissociated base in some way inhibits the action of the hydroxyl ions on cohesion.

We find that the addition of sodium chloride does not depress the water uptake in alkaline solutions to the same extent as in acid solutions, and conclude that under these conditions the sodium ion or the salt itself decreases the cohesion of the collagen. On the addition of sodium chloride to calcium hydroxide solutions, we find that with concentrations up to 0·05 M the water uptake increases with increasing salt concentration, from 0·05 to 0·5 M it remains approximately constant, and at higher concentrations begins to decrease again. We conclude that at concentrations up to 0·05 M the water uptake increases owing to the effect of the monovalent sodium in increasing the osmotic swelling; at concentrations between 0·05 and 0·5 M this effect, and that of the salt on the cohesion of the collagen, is balanced by the effect of salt in depressing osmotic swelling; and at higher concentrations the water uptake is decreased by the dehydrating action of the salt.

We have also observed that under conditions which reduce the cohesion of collagen, for example, sodium hydroxide solutions above pH 13, the addition of organic solvents miscible with water, for example, acetone, n-propyl alcohol and dioxan, causes the collagen to disperse and to a large extent dissolve.

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[1] Procter, *J. Chem. Soc.*, **105**, 313 (1914).
[2] Donnan, *J. Soc. Leather Trades Chem.*, **17**, 36 (1933).
[3] Bolam, "The Donnan Equilibria" (London, 1932).
[4] Ostwald, Kuhn and Böhme, *Kolloid Beih.*, **20**, 412 (1925).
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Effect of Cetyl Pyridinium Bromide on the Water Absorption and Swelling of Soil

SURFACE-ACTIVE quaternary ammonium salts containing a long-chain paraffin group find a number of technical and medical uses due to their adsorption by textiles, bacteria, etc. It has now been found that the adsorption of such compounds by clay particles affects the water absorption and swelling characteristics of soils.

Experiments have been made with a clay loam soil from Harmondsworth, containing 28 per cent of particles having equivalent diameters smaller than 2 μ. This soil was treated with hydrogen peroxide to remove organic matter and then leached with 0·2 N hydrochloric acid to saturate the clay fraction with hydrogen. Groups of four cylinders were then prepared to a constant volume, 1 in. high and 1 in. in diameter, constant weights of mineral matter and of liquid being used in the preparation of each cylinder. Amounts ranging from 0 to 1·0 per cent of a commercial form of cetyl pyridinium bromide were added to the different groups of cylinders, the salt being incorporated in the water added. After preparation, the average moisture content, bulk density and air-voids content of all the specimens was 12 per cent, 1·9 gm./c.c. and 14 per cent respectively. The cylinders were then allowed to stand in a humid atmosphere for three days to permit conditions of equilibrium to be established. After this time the circular surfaces of the cylinders were given a thin coating of paraffin wax, and they were allowed to take up water by standing on saturated sand contained in 100 ml. beakers.

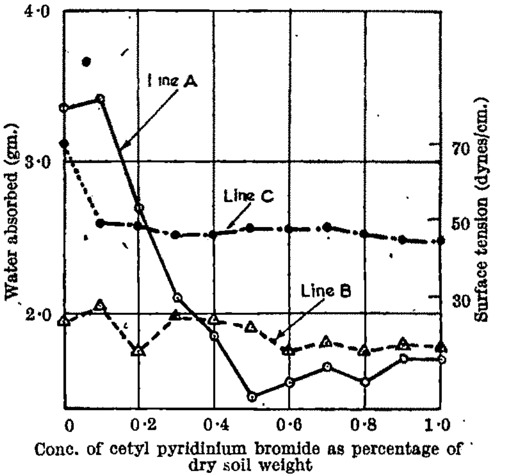

Fig. 1. EFFECT OF CETYL PYRIDINIUM BROMIDE ON THE WATER ABSORPTION OF HARMONDSWORTH CLAY LOAM SOIL

Line A, experimentally determined water absorption; line B, theoretical water absorption to saturate specimens, assuming no swelling; line C, surface tension of cetyl pyridinium bromide solutions of equivalent concentrations

Fig. 1 shows the amounts of water absorbed by the different batches of specimens after 16 hr., each point being the average result obtained from four determinations (line A). The dotted line (line B) indicates the calculated amounts of water required to fill the air-voids in the cylinders, assuming that the latter do not increase in volume. The same diagram shows the surface tension of aqueous solutions of cetyl pyridinium bromide, at concentrations equal to those at which the salt was present in the soil-water (line C).

It will be seen that there is a marked reduction in the water absorption between 0·1 and 0·5 per cent concentration, the reduction being about 57 per cent. The values of the surface tension between the same equivalent concentrations show no such uniform reduction, the variation being about ± 2 per cent. It is concluded that the reduction in the water absorption indicated by line A is not due to a reduction of the surface tension at the air/water interface. Beyond a concentration of 0·5 per cent cetyl pyridinium bromide, there is no further marked reduction in the water absorption, the values reflecting to some extent the volumes of the air-voids in the soil.

It was concluded from this experiment that the addition of cetyl pyridinium bromide to a clay soil will not prevent the movement of water through the pore spaces of the soil, but will inhibit the adsorption of water by the clay particles, and hence the swelling of the latter. More direct evidence for this view is provided by a second experiment, in which measurements were made of the linear swelling of the soil when treated with the same concentrations of the salt.

Flat cylindrical specimens, 2 in. in diameter and 0·5 in. high, were made up at a moisture content of 17 per cent and bulk density of 1·9 gm./c.c. They were compacted between filter papers into brass moulds having perforated bases through which water was allowed to come into contact with the soil. A dial-gauge, reading to 0·001 in., was fitted to the moulds to record the vertical movement of brass cylindrical plates resting on the specimens.

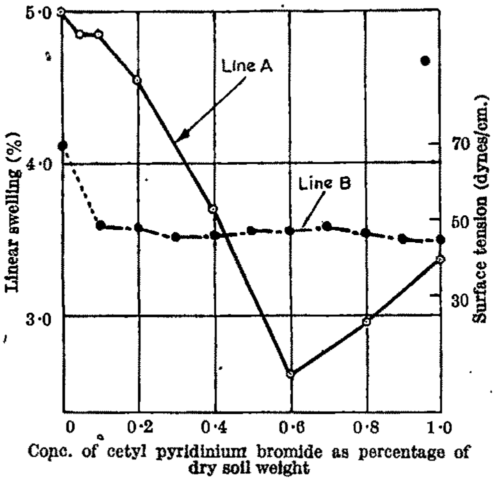

Fig. 2. EFFECT OF CETYL PYRIDINIUM BROMIDE ON THE SWELLING OF HARMONDSWORTH CLAY LOAM SOIL

Line *A*, experimentally determined swelling; line *B*, surface tension of cetyl pyridinium bromide solutions of equivalent concentrations

Fig. 2 shows the linear swelling of the soil specimens, expressed as a percentage of the original height, plotted against the concentration of cetyl pyridinium bromide (line *A*). Each point gives the average value of duplicate determinations. The curve relating surface tension and concentration for aqueous solutions of the salt is reproduced again (line *B*) for comparison. The swelling curve has a similar form to the water absorption curve shown in Fig. 1, except that the swelling reaches a minimum value at 0·6 per cent, after which a steady increase takes place to 1·0 per cent. The maximum reduction of swelling obtained is 48 per cent of the original value for the untreated soil.

It was found in earlier unpublished work that the treatment of soil with an aqueous solution of cetyl pyridinium bromide reduces the heat of wetting. It is considered that the reduction in swelling and water absorption demonstrated in the above experiments may be due to the adsorption of cetyl pyridinium ions on the surfaces of the particles of the clay fraction, which is the component responsible for the swelling properties of a soil, thereby reducing their tendency to hydrate.

I am indebted to Miss O. M. Powell, who carried out the experimental work.

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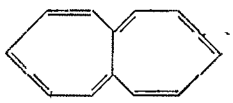
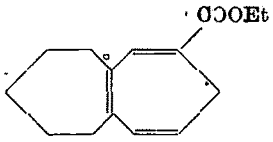
Synthesis of Cyclic Conjugated Polyolefins

CONSIDERABLE interest is attached to the properties of cyclic conjugated polyolefins[1], and in a number of studies we have been exploring possible routes to analogues and derivatives of such mono- and bi-cyclic structures as those of cyclo-octatetraene and azulene. In attempts to prepare the azulene analogue (I), for which the name 'heptalene' is suggested, the ethyl (0 : 5 : 5)-bicyclo-duodecatriene carboxylate (II) was submitted to vapour-phase dehydrogenation by the method of Linstead, Millidge, Thomas and Walpole[2]. The main product of this reaction, however, was a mixture of dimethyl-naphthalenes, formed through rearrangement of the carbon skeleton. In an attempt to prevent such rearrangement, a higher speed vapour-phase dehydrogenation technique was evolved, which allowed very brief contact with the catalyst and rapid removal of the products from the zone of the reaction. Under these conditions the product of reaction was a deep blue oil from which azulene-like material was extracted in small yield with 85 per cent phosphoric acid, and regenerated from solution by addition of water.



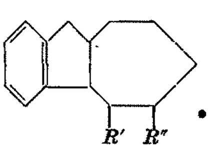
I



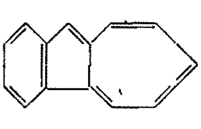
II

This product could be saponified to yield a green sodium salt. A study of its visible absorption spectrum has shown it to have strong absorption maxima at 700, 632, 605 and 580 mμ, and weak absorption maxima at 734, 676, 662 and 651 mμ. These spectral characteristics are very similar to those of 2-ethyl-6-carboethoxy-azulene[3], which shows strong maxima at 668·5, 608·5, 563 (broad band) and weak maxima at 643, 630·5, 619, 586 and 575·5 mμ. Even the best yields of the blue dehydrogenation product have, however, so far been too small to allow of its purification and characterization; and whether a heptalene structure has been produced, or whether an azulene has been formed as a result of a rearrangement reaction, remains to be proved. In either case, however, our experiments to date are significant in that they demonstrate that the heptalene structure is not one which can be generated by dehydrogenation with the same facility as that of azulene. That a careful study of dehydrogenation conditions is essential in the exploration of syntheses of this type is indicated by other experiments.

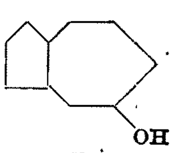
Thus, when a mixture of carbinols (III; $R' = H$, $R'' = OH$ and $R' = OH$, $R'' = H$) was heated with palladium/charcoal at 300° C. for several hours, only a brown resinous substance was produced which gave no addition product with 2 : 4 : 6-trinitrotoluene. Cook, McGinnis and Mitchell[4] have reported a similar failure to prepare 5 : 6-benzazulene by this method. In our hands, dehydrogenation by the method of Linstead *et al.*[2] was equally unsuccessful; but when a higher-speed dehydrogenation was used, there was produced in the first few minutes a trace of a colourless crystalline substance of m.p. 94–97° C. (almost certainly phenanthrene), and this was followed by distillation of an intensely deep blue oil. This yielded 1 : 2-benzazulene (IV) as deep green plate-like crystals on contact with alcohol. It could be recovered unchanged from its solutions in 85 per cent phosphoric acid, and was readily characterized by the formation of a trotylate.



III



IV



V

The higher-speed dehydrogenation method has also been used by us with advantage for the production of azulene from V, the yields obtained being higher than those by other dehydrogenation techniques. Its applications above, as well as to a variety of other structures, will be published in detail elsewhere.

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[2] Linstead, Millidge, Thomas and Walpole, *J. Chem. Soc.*, 1146 (1937). Cf. Plattner, Furst and Jirasek, *Helv. chim. Acta*, 29, 741 (1946).

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Coprecipitation of Uranous Sulphate with Rare-Earth Double Sulphates

SINCE uranous sulphate forms no double sulphate with sodium sulphate or the rare-earth sulphates which is insoluble in water or dilute sulphuric acid, it might be expected that tetravalent uranium would pass into the filtrates when the cerium group is separated from acid solutions of the sulphates as the double sodium sulphates. Certain cations not necessarily tripositively charged, for example, Th^{4+}, the ionic radii of which are close to those of the cerium group elements[1], tend to be coprecipitated when this group is separated as double sodium sulphates[2], although no corresponding insoluble double sulphates are known. The radius of the uranous ion, however, is almost equal to that of yttrium[1], so there is added reason to expect tetravalent uranium in the soluble double-sulphate fractions. It has been found, on the contrary, that uranous sulphate in acid solution is either partly or wholly precipitated with cerium and the cerium group elements, the extent of coprecipitation depending mainly on the concentration of uranous and rare-earth ions. When the uranium concentration is sufficiently high, a pale green precipitate is obtained, the colour of which is more evident in artificial light.

The following figures were obtained by stirring anhydrous sodium sulphate into a solution of the composition: Ce_2O_3, 32 gm./l.; UO_2, 3·4 gm./l.; H_2SO_4, 106 gm./l., and filtering after standing 30 min. at 20° C. Uranous sulphate was prepared by electrolytic reduction of uranyl sulphate at a lead cathode, air being blown through the solution before mixing in order to oxidize trivalent uranium[3].

Mol. Na_2SO_4 per mol. of Ce_2O_3	1·1	2·2	3·2	4·3	5·4	6·5
Ce_2O_3 precipitated, per cent	72	96	97	97	98	99
UO_2 coprecipitated, per cent	34	71	85	92	95	97

When 6 mol. of sodium sulphate per mol. of Ce_2O_3 were added to a solution of the composition: Ce_2O_3, 24 gm./l.; UO_2, 23 gm./l.; H_2SO_4, 200 gm./l. under the same conditions as before, 80 per cent of the uranous oxide and 99·8 per cent of the cerous oxide were precipitated. The weight fraction uranium oxide to uranium + cerium oxide in the precipitate was approximately 0·43. In a similar experiment with a sulphate solution of the composition: mixed rare-earth oxides, 27 gm./l.; UO_2, 2·7 gm./l.; ThO_2, 3·2 gm./l.; H_2SO_4, 130 gm./l., 98 per cent of the uranous oxide and 98 per cent of the rare-earth oxides were precipitated by 6 mol. of sodium sulphate.

An almost quantitative precipitation of uranous ion can thus be obtained at a rare-earth oxide concentration of not less than 24–32 gm./l., provided that 98 per cent or more of the rare earths are precipitated and that the ratio of uranous oxide to rare earth oxides in solution is 0·1 or less. No significant amount of uranyl sulphate is coprecipitated with sodium cerium sulphate under similar experimental conditions. The precipitate is appreciably soluble in water, both uranous and rare-earth sulphates passing into solution; but the green colour of the precipitate cannot be removed by washing with water.

Earlier work[2] with a solution of the composition: mixed rare-earth oxides, 30 gm./l.; ThO_2, 3·6 gm./l.; H_2SO_4, 109 gm./l. has shown that only 46 per cent of the thoria is coprecipitated with the double sulphates by addition of 6 mol. of sodium sulphate per mol. of mixed oxides. Quite large variations in acid concentration, temperature and time of standing had little effect on this result. There is thus only a qualitative resemblance between the coprecipitation of tetravalent uranium and thorium ions with rare-earth double sulphates. The coprecipitation of thorium, however, is more understandable, since the radius of the thorium ion is some 5 per cent greater than that of the uranous ion and is approximately equal to that of gadolinium.

Although adsorption may play a part in the coprecipitation of uranium and thorium with sodium rare-earth sulphates, it is clear that other factors are involved besides ionic size or ionic charge and the solubility of the double sulphates in the system water – sodium sulphate – sulphuric acid. These must ultimately be traced to the different electronic structures of uranous, thorium and rare-earth ions.

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[1] Hassel, O., trans. by R. C. Evans, "Crystal Chemistry", 11 (Heinemann, London, 1935).

[2] Pilkington, E. S., and Wylie, A. W., *J. Soc. Chem. Ind.*, in the press.

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Variation in Density of Cerium Oxide

THE existence of polymeric varieties of cerium oxide was proposed so long ago as 1897[1], this contention being based, *inter alia*, upon the fact that the colour of the oxide is dependent, not only on its purity, but also upon the nature of the salt from which it is prepared by ignition. Although density figures quoted in standard text-books show obvious variation, I have been unable to trace any data correlating the density of cerium oxide prepared in different ways with the possibility of its existence in polymeric forms.

My starting material was cerium oxide of higher than 99·5 per cent purity, the remaining less than 0·5 per cent being other rare earth oxides. This was converted to sulphate with hot concentrated sulphuric acid, and then obtained in solution by diluting with water. Different portions of the sulphate solution thus obtained were then precipitated as oxalate, double sodium sulphate, and as hydroxide with ammonia. Two oxalate precipitates were converted to hydroxide and carbonate by digestion respectively with sodium hydroxide and carbonate; likewise with the double sodium salts. The carbonates and hydroxides were filtered off and washed free of alkalis and soluble salts. One oxalate precipitate was ignited as such, and a further portion of the initial sulphate solution evaporated to dryness and the sulphate thus obtained ignited. All specimens—hydroxides, carbonates, oxalate and sulphate—were ignited gradually and finally at 1,200° C. for 1 hour to ensure complete conversion to oxide.

The cold oxides were then passed through a 100-mesh screen and their densities determined pyknometrically against water at 25° C. Although exceptional accuracy was not aimed at in the density determinations, the results were all obtained under the same conditions, so that, although the values obtained may not be specific, their interrelationship is the same.

		Density	Colour
Oxide 1	Ignition of oxalate	6·64	Light salmon
3	Ignition of hydroxide from double sulphate	6·63	Light salmon
5	Ignition of carbonate from oxalate	6·52	Buff
2	Ignition of hydroxide	6·51	Buff
4	Ignition of hydroxide from oxalate	6·32	Natural
7	Ignition of sulphate	6·27	Light natural
6	Ignition of carbonates from double sulphate	6·03	Yellow

It will be seen that, within experimental error, four oxide forms can be differentiated: oxides 1 and 3; 5 and 2; 4 and 7; and 6; with average densities of 6·635; 6·515; 6·295; and 6·03, respectively. Although it is obvious that the mode of preparation of the oxide, namely, crystal structure and particle shape of the parent compound, influences the density of the product, it is not possible to determine any sequence for this.

If it can be accepted, however, that the polymeric forms of cerium oxide, $(CeO_2)_{40}$, $(CeO_2)_{58}$, and $(CeO_2)_8$, do exist[2], and that these may be differentiated, as may most polymers, by their densities, then it is considered probable on the basis of the above figures that a fourth polymeric form of cerium oxide exists.

X-ray analysis could no doubt verify, or otherwise, this possibility, but in the absence of the necessary equipment for this work, further investigations are being undertaken on this subject from the chemical aspect.

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[1] Wyrouboff and Verneuil, *C.R. Acad. Sci.*, 124, 1230 (1897); 127, 863 (1898); 128, 501 (1899).

[2] Wyrouboff and Verneuil, *Bull. Soc. Chim.*, 21 (3), 11 (1899); Conf. de la Soc. Chim. de Paris, 1903.

Age of the Baker's Hole Coombe Rock, Northfleet, Kent

Prof. W. B. R. King and Dr. K. P. Oakley discussed this subject in *Nature* of January 13, 1945 [1].

In my opinion the Montières Coombe Rock is Riss I plus Riss II, with Levallois I and II *without any trace of Acheulean.* The coombe rock of Baker's Hole contains a Levallois with large flakes plus bifaces which, according to King and Oakley, resembles my Levallois V industry of broad but not too thick flakes, and abundant heart-shaped and triangular bifaces. Their opinion is probably right, and for some years I have suspected my mistake; but there are two solutions. If, as I am led to believe (without personally being able to control the Northfleet Coombe Rock), Baker's Hole is really Rissian, one must explain the difference in the industries between Montières and this English site.

When I first set forth my views on this subject, my knowledge of the industry of Northfleet and the various French and English Levallois levels was incomplete. In England the true Old Levallois exists in a solifluxion layer at Bapchild, Kent[2]; but it is not the same as that of Northfleet, which is analogous to our Levallois V. In France the Levallois V is not derived from Levallois IV. It may be that, while we had our Levallois III–IV, England had already reached a Levallois stage more or less Levallois V, and that during the low sea-level of the Würm it crossed over to France, driven out of the northern islands by the Würm I glaciation. If the coombe rock of Baker's Hole is Würm, as in France, the Levallois V should be on (not in) the solifluxion gravel; but the contrary is the case in Baker's Hole, where the Levallois is below the coombe rock, which is evidence for making the origin of our French Levallois V a little later.

The same thing applies to the French Levallois III–IV, which is similar to the Markkleeberg industry shown by Grahman to be not Riss–Würm but Mindel–Riss. During the Riss this latter was probably driven back from Germany towards the west, England included. The same industrial stations may, therefore, alternate between the zones of the big glacial extensions and the western zones of less severe climatic conditions, and have taken advantage of the low sea-level draining the Channel at each maximum glaciation.

Let us now return to the Acheulean types of Swanscombe referred to as *superior*, that is to say, Acheulean IV–VII of the Somme. The answer is that in France during the Mindel–Riss the limande (ovate) is the dominant type until the end of Acheulean III (with always sporadic pointed pieces which become more numerous towards the end of Acheulean III and with the appearance, as at Swanscombe, of a few small pieces of Levalloisian technique). In all of the Mindel–Riss deposits at Swanscombe, there are types which are generally found in France in the inter-Riss: Acheulean IV, which is Commont's workshop-level, and which continues after the Riss II (Old Loess with Acheulean V) and finally in the red fissured clay of the Riss–Würm of the 30-metre terrace. This is probably a phenomenon of precession and migration.

Under these conditions, regional differences should not cause surprise. Only careful and *objective* observations can in time lead us to establish these regional differences, which are due to glacial extensions and concomitant continental connexions, alternating between England and the rest of Europe with high sea-levels re-occupying the English channel and the North Sea.

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Dependence of Anomaloscope Matching on Viewing Distance or Field Size

I READ with great interest the letters of Mr. R. G. Horner and Mr. E. T. Purslow and of Dr. J. H. Shaxby[1], in which they describe the changes which have to be made in the red and green mixture required to match a given yellow, as the visual angle is altered. They remark, "It is more surprising that such effects should extend to angular fields between 1° and 3° . . ." I have recently confirmed their conclusion and have found that the effects extend to angular fields of between 5° and 25°. I have also performed some additional experiments in an attempt to elucidate the cause of the effect.

Some colour filters were prepared, the properties of which are shown in Table 1.

TABLE 1. SPECTRAL TRANSMISSIONS OF COLOUR FILTERS

Class of filter	Series 1	Series 2	Series 3	Series 4
Dichromatic	0·69μ and 0·55μ	0·69μ and 0·53μ	0·69μ and 0·51 μ	0·69μ and 0·50μ
Monochromatic	0·580μ	0·575μ	0·570μ*	—*
Wide band	0·51–0·70μ	0·52–0·68μ	0·52–0·66μ	0·47–0·62μ
Yellow-blue				0·565μ and 0·450μ

The dichromatic filters transmitted two narrow spectral bands the mean wave-lengths of which are shown in the table. Each of the monochromatic filters transmitted a single band having the mean wave-length shown. The wide-band filters had a broad transmission which occupied a position in the spectrum between the wave-lengths indicated. Four series were prepared, and the filters in each series were adjusted to match one another as closely as possible in hue and saturation, at a light intensity of 50 ft. c. and a visual angle of 5°. Satisfactory matching was obtained except in the cases of the filters marked with an asterisk. The failure to obtain an exact match was due to the fact that the dichromatic filter of Series 3 transmitted a cream-coloured light, and in consequence the monochromatic filter was definitely more saturated. The same statement would have applied even more forcibly to the monochromatic filter in Series 4, since the light transmitted by the dichromatic filter of this series was almost white. Instead of a monochromatic filter, a dichromatic yellow-blue filter was prepared having the transmission shown in Table 1.

The filters in each of the series were now viewed in pairs at visual angles of about 1°, 5° and 25°, with the results shown in Table 2.

TABLE 2. COLOUR CHANGES WITH ALTERATIONS OF VISUAL ANGLE

Filters being compared	Series 1	Series 2	Series 3	Series 4
Dichromatic and monochromatic	4	4	4	–
Wide-band and monochromatic	3	2	1	–
Dichromatic and wide-band	1	2	3	6
Dichromatic and yellow-blue	–	–	–	10
Wide-band and yellow-blue	–	–	–	4

The highest score was given where there was a very obvious colour change with alteration of visual angle. Smaller scores were given in accordance with the visual estimate of the amount of the colour change. Comparing the scores in the four series when the dichromatic are compared with the monochromatic filters, it will be observed that altering the wave-length of the green component from 0·55 to 0·50 produces little or no effect on the score. This suggests that some alteration in the blue sensation is not responsible for the effect, for if it were it would be expected that Series 2 would have a higher score than Series 1, and Series 3 a higher score than either. On the other hand, that some alteration in the red sensation may be responsible is suggested by the fact that the scores for both wide-band versus monochromatic and for dichromatic versus wide-band, are smaller than the scores for dichromatic versus monochromatic. It would be expected that such would be the case if red played an important part, since the dichromatic filters transmit the most red, the monochromatic filters the least red, while the wide-band filters occupy an intermediate position so far as red content in the light transmitted is concerned.

To summarize the facts so far known: (1) with reduction of visual angle, filters which transmit red freely become redder than those which do not, and vice versa; (2) this effect is still found at visual angles as large as 25°.

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A Unified Theory of Spontaneous Electrical Fluctuations in Thermionic Valves

THE phenomena of intrinsic fluctuations of voltage and current in electric circuits are generally regarded as belonging to either of two classes, usually referred to as 'thermal fluctuation' and 'shot effect'. The former, the precise counterpart of the Brownian motion of mechanical systems, has its origin in the irregular thermal movement of the constituent particles of matter; the latter, which occurs in thermionic valves and similar devices, is considered to be essentially due to the electronic structure of electricity.

Although it therefore seems that the two phenomena are of an entirely different nature, it has frequently been pointed out that they become identical in certain circumstances[1]. Theoretical considerations have led me to the conclusion that not only in such limiting cases but quite generally the two phenomena are, in fact, only two aspects of one and the same statistical fluctuation process, which can be theoretically treated by the application of the principles of statistical thermodynamics. By following this line of approach, it becomes possible to derive, in a much simpler way than by the established theories, an approximate formula for the shot effect in diodes which covers the whole range of the characteristic. A detailed paper on this investigation is being published elsewhere. Here the main resulting formula only is given, and its application to some special cases discussed.

Let I be the mean current through the valve, V_a the applied anode potential, I_s the saturation current for the filament temperature T, e the magnitude of the electronic charge, and k Boltzmann's constant. Then the mean square of the fluctuation of current, within the interval Δf of the 'frequency spectrum' of that fluctuation, is given by

$$\overline{(\delta I)_f^2} = 2kT\Delta f \cdot \frac{g_c^2 + g_a^2}{g_c + g_a}, \tag{1}$$

where

$$g_a = \left(\frac{\delta I}{\delta V_a}\right)_{I_s} \tag{2}$$

is the differential valve conductivity; and

$$g_c = \left(\frac{\delta I}{\delta I_s}\right)_{V_a} \cdot \frac{eI_s}{kT}. \tag{3}$$

In the so-called 'retarding field region' (with negative 'anode' potential), where

$$I = I_s \exp\left(\frac{eV_a}{kT}\right),$$

one has from (2) and (3)

$$g_a = g_c = \frac{eI}{kT};$$

hence formula (1) becomes

$$\overline{(\delta I)_f^2} = 2eI\Delta f. \qquad (4)$$

It was shown by D. K. C. MacDonald and me that this formula is indeed strictly valid in the retarding field region[2].

In the so-called 'space-charge limitation' region (at the lower bend of the characteristic) one would expect $g_c = 0$ as, according to the Langmuir – Child relation, I should be independent of I_s. This immediately leads to

$$\overline{(\delta I)_f^2} = 2kTg_a\Delta f. \qquad (5)$$

The same relation follows generally for $g_a = g_c$. In any case within this region $0 \leqslant g_c/g_a \leqslant 1$; thus, according to (1), the fluctuation formula can be written in the form

$$\overline{(\delta I)_f^2} = 2eI\Delta f \,.\, \Gamma^2, \qquad (6)$$

where the 'space-charge reduction factor' Γ^2 is given by

$$\Gamma^2 = \lambda \frac{kT}{eI} g_a, \qquad (7)$$

and λ is a constant of the order of magnitude unity. This result is also in agreement with experiment[3].

Finally, in the saturation region where $I = I_s$ is independent of V_a, one has $g_a = 0$, and consequently one obtains Schottky's classical shot effect formula in the form (4).

It has been argued[1] that a diode with two hot electrodes at the same temperature T (double diode) should be equivalent to a 'resistance' $1/g_a$ of the same temperature, and hence the fluctuation should obey Nyquist's thermal fluctuation formula, that is, formula (5) with a factor 4 instead of 2. In order to check this prediction, fluctuation measurements in double diodes were carried out, on my suggestion, by D. K. C. MacDonald some time ago[4], with the result that the relation was satisfied for low temperatures only, and that the ratio between measured and calculated fluctuation increased steeply with increasing temperature. This unexpected result can be immediately understood in the light of the present theory without any further assumptions. For it follows from the theory that formula (1) should also hold for a double diode when the factor 2 is replaced by 4. Thus one obtains the fluctuation formula

$$\overline{(\delta I)_f^2} = 4kTg_a \frac{1 + \alpha^2}{1 + \alpha} \Delta f \qquad (\alpha = g_c/g_a). \qquad (8)$$

This coincides with Nyquist's law only for $\alpha = 0$ and $\alpha = 1$ (and approximately within these limits), but predicts increasingly larger fluctuation values for increasing values of α. From the valve data kindly supplied to me by Dr. MacDonald, it follows, indeed, that α is of the order of magnitude unity up to filament temperatures of about 2,100° K., and from there on increases rapidly with increasing temperature; this is in satisfactory agreement with the fluctuation measurements mentioned.

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Production of High-Frequency Energy by Ionized Gases

SINCE the publication in this journal[1] of a note by P. C. Thonemann and R. B. King, entitled "Production of High-Frequency Energy by Ionized Gases", a large number of experiments have been made in this laboratory on the noise and oscillations in cold-cathode and hot-cathode discharge-tubes, when placed in a transverse magnetic field[2]. Our experiments were carried out with nitrogen at a pressure varying from 1 to 50 μ mercury in cold-cathode discharge tubes. The greatest care was taken to localize the magnetic field of an electromagnet, to hold constant the pressure at a fixed level and to purify the gas (spectroscopically pure nitrogen).

The work was done with a superheterodyne receiver covering the range from 1·30 to 2·60 metres, coupled by small condensers to the cathode or the anode on one side, and to a Langmuir probe on the other side. The probe was constructed as described by F. D. Greeves and J. E. McF. Johnston[3] and J. L. Spencer-Smith[4]. Six probes were placed in the discharge, each one along a diameter of the circular section of the tube, and movable by means of a magnetic coil.

The noise occurred only when the magnetic field was applied near the anode of the tube. It fell to less than 10 μV. when the magnetic field was applied near the cathode or near the probe. When the electromagnet was moved from the neighbourhood of the anode, the noise decreased rapidly. This result is very different from that reported by Cobine and Gallagher[5] when working on wave-lengths greater than 50 metres.

When the tube current and the pressure of the gas were constant, the noise-level increased when the magnetic field increased, reaching a sharp maximum for some fixed value of the field. The noise decreased while the magnetic field was increased further until it reached the value where the discharge was cut off. When the tube current was increased, the magnetic field producing the maximum noise was also increased.

With constant pressure and magnetic field, the noise increased when the tube current continuously increased and reached a certain maximum, then decreased to a very low value. The resulting position of the noise maximum moved towards the heavier currents when the applied magnetic field increased. When the applied magnetic field was held constant, the tube current corresponding to the noise maximum increased when the pressure decreased.

The use of probes at fixed potentials showed that the maximum of noise is produced when the potential of the probe is equal to the local potential in the discharge. This result cannot be explained by changes of space-charge conditions far from the probe studied, for it was shown that the variation of potential of a probe did not disturb the space-charge conditions near the other probes even when the magnetic field was applied.

Contrary to the results of Cobine and Gallagher[5], a sharp maximum of noise was found when the probe potential crossed the local potential in all the experiments which have been carried out.

The Cobine and Gallagher hypothesis and the J. J. Thomson – Langmuir theory of electron oscillations in ionized gases do not seem sufficient to explain the results of these experiments.

A complete account of the present work will appear in due course in the *Revue Scientifique*[6].

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Gyro-interaction of Radio-Waves Obtained by the Pulse Method

IN March and April 1946, during fourteen nights, experiments were made by the Institute of Technical Physics of the University of Naples in association with the Institut Elettrotecnico Nazionale of Turin, the Vatican Radio and Italian Navy and Air Force, in order to verify if there is a resonance effect in the interaction of radio-waves (gyro-interaction) according with V. A. Bailey's suggestion of 1937[1].

For this purpose a method devised by me was used, consisting in varying the frequency of the disturbing station around the local gyromagnetic frequency, to obtain the maximum of the phenomenon. As soon as the maximum was revealed at the receiving apparatus, the frequency of the disturbing station which has produced the maximum was measured by means of a frequency-meter. This measured frequency is very close to the local gyromagnetic frequency. By doing this, it was possible with a power of 700–800 watts to measure the local gyromagnetic frequency $\Omega = eH/2\pi m$, and consequently the value of the total terrestrial magnetic field H in the ionosphere, and also to ascertain a regular variation of the gyro-frequency during the night.

In order to verify the results of those experiments, further investigations were made between January and July 1947, in association with the Italian Navy. The military stations of Augusta (630 m., 1 kW.) and Taranto (1,250 m., 1 kW.) operated as emitters, and Venice, La Spezia, Leghorn and Roma (Sant' Alessandro) as receiving stations. Naples, the wavelength of which varied from 265 to 285 m., operated as disturbing station.

In order to obviate the lack of power of the Naples station (400–500 watts), which, in the first experiments, made observation of the phenomenon very difficult, the pulse-method was applied to this station. The experiments made using the pulse-method have confirmed my suggestion, because, although the power was not much varied, it is believed that the transient is more efficient than a continuous wave in the interaction.

The gyro-interaction was observed frequently, sometimes during a whole hour of transmission, and very easily, notwithstanding the remarkable strength of the atmospheric static. The number of the observations (about forty) obtained in Venice, and often also in Rome, is sufficient to confirm clearly the gyro-interaction. The phenomenon was never observed in Leghorn and La Spezia, perhaps on account of the fact that the reflexion points of the waves of the emitting stations were too far from the 'sky' of Naples. The wave-lengths of the disturbing station which have caused the gyro-interaction are included between 265 and 282 metres. The variation law of the disturbing station frequency was 4 by 4, 2 by 2, and very often 1 by 1 metre. The behaviour of the phenomenon was generally similar to that in 1946 during the three hours of transmission. While in the first hour the gyro-frequency was low, about 282 metres, in the second hour it became higher, about 272 metres or less, and in the third hour about 265 metres. In 1946 and 1947, the interaction was stronger between 0200 and 0300 local time, and less easily observable between 0400 and 0500.

The experiments are being continued with more powerful stations.

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Relativity of Accelerated Motion

ACCORDING to the general theory of relativity, accelerated motion is relative; that, however, is difficult to reconcile with experimental evidence; for example, in the case of rotation.

The relativity of accelerated motion follows from the general covariancy of physical laws; thus, if $T_\alpha^0 = 0$ (for all four components) represents a physical law in one system of co-ordinates, then in any other system the law is

$$T_\mu = \frac{\partial x_\alpha^0}{\partial x_\mu} T_\alpha^0 = 0; \qquad (1)$$

that is, it preserves its form.

Laws of physics can therefore give us no information about the system of co-ordinates used; and, since four-dimensional curvilinear co-ordinates correspond to accelerated motion, the latter is purely relative. This difficulty can be explained as follows.

Equation (1) presupposes that (*a*) there is one to one correspondence between the two spaces, (*b*) the transformations $\partial x_\alpha^0/\partial x_\mu$ remain finite throughout the space; that, however, need not be the case in a transformation between a Galilean and accelerated spaces.

Accelerated motion is equivalent to a gravitational space, and we should expect the latter to have an impenetrable boundary, since otherwise a particle might acquire in it an infinite velocity. For example, in the case of Einstein's gravitational space, the boundary is $r = 2m$. There is, therefore, no one to one correspondence between a Galilean and accelerated spaces.

If a Galilean space can be transformed into an accelerated one, we should expect that on the boundary the transformations $\partial x_\alpha^0/\partial x_\mu$ would become infinite, and (1) would break down. Unfortunately, there are no solutions for accelerated spaces, except in the case of a uniform accelerated motion[1].

The fundamental form in this case is

$$ds^2 = (1 + 2\omega x)\,dt^2 - \frac{dx^2}{1 + 2\omega x} - dy^2 - dz^2 \qquad (2)$$

$$\omega = g/c^2,$$

where g is the acceleration.

The corresponding transformations are

$$x_0 = \frac{(1 + 2\omega x)^{1/2}}{\omega} \cosh \omega t - \frac{1}{\omega}\,;$$

$$t_0 = \frac{(1 + 2\omega x)^{1/2}}{\omega} \sinh \omega t\,; \qquad (3)$$

whence

$$\begin{aligned} \frac{\partial x_0}{\partial x} &= (1 + 2\omega x)^{-1/2} \cosh \omega t, \\ \frac{\partial x_0}{\partial t} &= (1 + 2\omega x)^{1/2} \sinh \omega t, \\ \frac{\partial t_0}{\partial x} &= (1 + 2\omega x)^{-1/2} \sinh \omega t, \\ \frac{\partial t_0}{\partial t} &= (1 + 2\omega x)^{1/2} \cosh \omega t, \end{aligned} \qquad (4)$$

where x_0 . . . refers to Galilean space.

As can be seen from (3), the part

$$\left(x_0 + \frac{1}{\omega}\right)^2 - t_0^2 \leqslant 0$$

of Galilean space has no corresponding points in the curved space; the boundary is at $x = -1/2\omega$, and the transformations (4) become infinite on the boundary.

A phenomenon which can serve as a test is the rate of radiation of an accelerated electron; it is equal to the Poynting's flux:

$$\int \rho_n dS. \qquad (5)$$

In the case of a uniform rectilinear motion, (5) vanishes, and there is no radiation.

To find the radiation in accelerated motion, (5) is transformed to the new co-ordinates (3); the flux corresponding to the transformed tensor does not vanish; it leads to the correct value of the rate of radiation of an electron moving with acceleration g.

It is important to notice that the flow of energy takes place only through the singular plane $x = -1/2\omega$.

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A Statistical Criterion to Determine the Group to which an Individual Belongs

In a previous note[1], I have discussed the logical problems involved in the classification of an individual into one of two groups to which he can possibly belong. Some observations were the same as those given by Welch[2] in an earlier note. The solution derived above was identical with the discriminant function proposed by Fisher for this purpose. The corresponding problem when the individual has to be specified as a member of one out of many groups to which he can possibly belong does not appear to have been tackled. The following solution, which comes out as an obvious extension of the discriminant function analysis, has been derived so as to satisfy a logical set of requirements.

Let $\pi_1, \ldots, \pi_k$ be k populations with the corresponding probability densities $f_1, \ldots, f_k$, each containing p measurements on an individual as variables. If an individual can be represented by an ordered set of p measurements or a point in a space of p dimensions, then the problem requires a division of the space into mutually exclusive regions $R_1, \ldots, R_k$, with the rule of procedure of assigning an individual to π_i if he belongs to R_i.

Let $P(I \subset R_i \mid \pi_i) = \beta_i$ denote the probability of an individual I of π_i falling in R_i. If the above rule is applied to a collection of individuals in which the proportion of those belonging to π_i is p_i then the proportion of misclassifications will be $1 - (p_1\beta_1 + \ldots + p_k\beta_k)$. If this has to be made a minimum, then using the calculus of variations one finds that the region R_1 is to be chosen as $p_1f_1 \geqslant p_2f_2$, $p_1f_1 \geqslant p_3f_3, \ldots, p_1f_1 \geqslant p_kf_k$, and similarly the regions $R_2, \ldots, R_k$; it is easy to see that the regions so constructed are mutually exclusive and they cover the whole p-dimensional space.

In case the p's are not known and the individual is equally likely to have arisen from any group, the solution is obtained by replacing the p's by unity in the previous one. It can be seen that in some problems the p's may be replaced by preassigned quantities depending on the risks associated with the misclassification of individuals belonging to various populations.

As an application of this, we may consider three multivariate normal populations with the identical dispersion matrix (α_{ij}) and its inverse (α^{ij}). If m_{ij} represents the mean of the i-th character in the j-th population and $x_1, \ldots, x_p$ are the measurements on an individual, then the following functions can be constructed.

$$L_1 = 2\Sigma(\alpha^{i1}m_{11} + \alpha^{i2}m_{21} + \ldots + \alpha^{ip}m_{p1})x_i - \Sigma\Sigma\, \alpha^{ij}m_{i1}m_{j1}$$

$$L_2 = 2\Sigma(\alpha^{i1}m_{12} + \alpha^{i2}m_{22} + \ldots + \alpha^{ip}m_{p2})x_i - \Sigma\Sigma\, \alpha^{ij}m_{i2}m_{j2}$$

$$L_3 = 2\Sigma(\alpha^{i1}m_{13} + \alpha^{i2}m_{23} + \ldots + \alpha^{ip}m_{p3})x_i - \Sigma\Sigma\, \alpha^{ij}m_{i3}m_{j3}.$$

The individual is assigned to π_1 if $L_1 \nless L_2$, $L_1 \nless L_3$; to π_2 if $L_2 \nless L_3$, $L_2 \nless L_1$; and to π_3 if $L_3 \nless L_1$, $L_3 \nless L_2$. The procedure is similar when more than three populations are involved. If in the above problem the dispersion matrices are not identical, the functions corresponding to the L's will be quadratic in the variables $x_1, \ldots, x_p$.

In some problems it may be necessary to assert with some degree of confidence that an observed individual has arisen from a particular population. In such a case each of the regions R_i may be divided into two mutually exclusive regions R'_i and D_i, so that if the individual falls in R'_i he is taken as belonging to π_i, and if in D_i he is provisionally accepted as belonging to π_i. This latter class may be denoted by π_i ?. The region R'_i may be chosen such that $P(I \subset R'_i \mid \pi_i)$ is maximum subject to the condition that the probability of an individual from any population other than π_i falling in R'_i is $\ngtr$ than a conventionally chosen value (0·05). Applying the calculus of variations one finds that the region R'_i is given by $f_i \geqslant a_1 f_1 + \ldots + a_kf_k$, where $a_1, \ldots, a_k$ are chosen such that $P(I \subset R'_i \mid \pi_i)$ is maximum subject to the condition $P(I \subset R'_i \mid \pi_j)$ for any $j \neq i$ is $\ngtr$ than 0·05. If in some situations the values of $P(I \subset R'_i \mid \pi_j)$ are specified in advance, then the a's can be chosen to satisfy these conditions.

It results in a certain amount of simplification if the region R'_i is defined as $f_i \geqslant A_1 f_1, f_i \geqslant A_2 f_2, \ldots, f_i \geqslant A_k f_k$, where the A's are suitably chosen. This, however, differs from the best region obtained above. The comparative advantages of these regions and their use in the statistical theory of choice of one out of many alternatives will be discussed in a paper to be published elsewhere.

I wish to thank Prof. R. A. Fisher for his valuable advice in the preparation of this note.

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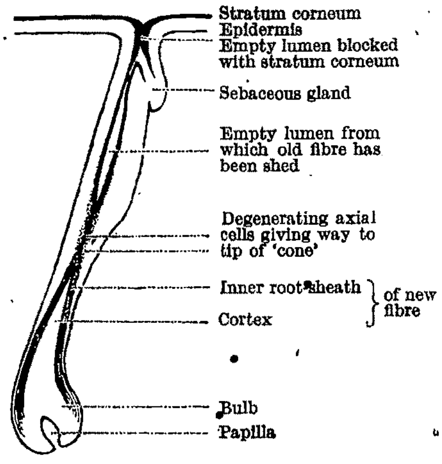
Replacement of Fibres in Sheep

EMPTY follicles, from which the fibres have apparently been shed, have been observed in skin samples from several breeds of sheep of various ages from one month to five years old, namely, Romney, Leicester and Blackface breeds. These skin samples were fixed either in formol saline or in Zenker and stained by a special combination of safranin, alum-carmine and picro-indigocarmine, details of which will be published elsewhere.

Examination of such follicles in horizontal and vertical serial sections has revealed the frequent occurrence of a type of shedding in which the old fibre is lost from the follicle when the new fibre is in the very early stages of its development, so that there is no possibility of the new fibre either growing alongside the old one or mechanically forcing it out, as described in other mammals by Segall[1] and others. In a few instances, a shed 'club-rooted' fibre was observed lying loosely in the distal part of the follicle some distance above the new fibre cone.

A second interesting feature is the occurrence in the follicle, immediately above the level of the tip of the new fibre cone, of an axis of cells histologically corresponding to the granular layer of the epidermis; these are apparently 'canal cells' as described in fœtal follicles in man by Stöhr[2], and also in sheep by Wildman[3]; but they are placed at a lower level in the follicle in our material than in the fœtal material described by Wildman. Segall, on the other hand, denies the presence of 'canal cells' in the guinea pig.


Stratum corneum
Epidermis
Empty lumen blocked with stratum corneum
Sebaceous gland
Empty lumen from which old fibre has been shed
Degenerating axial cells giving way to tip of 'cone'
Inner root sheath
Cortex
of new fibre
Bulb
Papilla

The accompanying diagram illustrates some details of the shedding process just described.

Further work is in progress, in order to determine the frequency and causes of this and other types of fibre-shedding in sheep, and to elucidate the cytological details of shedding and replacement of fibres. Fœtal material prepared in the above way will also be examined for the presence of an axis of granular layer cells in the developing follicles.

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New Divisions of Vascular Plants

A WIDELY used classification of vascular plants has recognized four divisions: Psilopsida, Lycopsida, Sphenopsida and Pteropsida[1]. The first three have been erected in the course of time out of Jeffrey's[2,3,5,5a] original Lycopsida. The fourth has not been changed from Jeffrey's[2,4,5,5a] original Pteropsida, and is further subdivided into Filicineæ (ferns) and Spermatophyta (seed plants)—both very large groups. The three divisions and these two subdivisions make five groups of plants widely recognized as distinct groups, though accorded a variety of taxonomic ranks.

Having to teach over the whole range of botany for some years, I have had problems of taxonomy at the higher levels forced on my attention, and for some time have felt a difficulty in expounding the Pteropsida as a coherent group corresponding to the Psilopsida, Lycopsida and Sphenopsida. Our present-day clearer knowledge of meristematic activity at apices, and in the origin of leaf primordia and branch primordia, together with other considerations, has led me to propose that the division Pteropsida be replaced by two divisions, the Filicopsida (ferns) and Spermatopsida (seed plants).

These two divisions may be differentiated as follows.

Filicopsida (the ferns, formerly Filicineæ—see Eames[1]—or Filicales—see Scott[6] and Bower[7]): (*a*) One superficial apical cell or 1–4 uniform superficial apical cells as initiators of structure. (*b*) Primary branching at the apex of the shoot infrequent, prominently dichotomous* and terminal. (*c*) Leaves arise from one or a very few superficial cells and develop superficial apical cells. (*d*) Sporangia of only epidermal origin. (*e*) Dispersed as spores.

Spermatopsida (the seed plants, formerly Spermatophyta—see Rendle[8] and Eames[1]—or Spermophyta—see Scott[6]): (*a*) Differentiated, massive meristem, several layers deep, as initiator of structure. (*b*) Primary branching at the apex of the shoot frequent, lateral and axillary to the leaves. (*c*) Leaves arise by combined activity of a zone of cells several layers deep, and develop a meristem which, if apical, is massive and differentiated. (*d*) Sporangia of essentially hypodermal origin. (*e*) Dispersed as seeds.

Just[9] has put forward a timely plea for observance of the Rules of Botanical Nomenclature in connexion with the major groups of plants. There are great difficulties here as the relevant data are much more complex than for the minor groupings—species, genus, etc. In the above proposal the name Pteropsida was dropped because, among other reasons, *Pteridium aquilinum* appears in Jeffrey's papers[2,4,5] to have no greater claim than many other species, including angiosperms and gymnosperms, to be the type species at the base of a hierarchy of names. I have not attempted to formulate descriptions of the new divisions in set terms, because, though the evidence points clearly to them as good divisions, there is yet more data to be produced anatomically (cf. Dormer[10]), experimentally (cf. Wardlaw[11] and Ball[12]) and bibliographically before we are in a position to do this with assurance of an approach to finality.

This proposal was put before the Botanical Sciences Section of the Sixth Science Congress of the Royal Society of New Zealand, on May 20 of this year. The full statement of the reasons for the proposed change in status and for the choice of names for the new divisions will appear in the published report of the Congress[13]. The present communication is to give a wide and early notice so that those interested may be prepared to receive the proposals with considered criticism.

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June 18.

* Cases of divergence from this are held within the division by other features.

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[11] Wardlaw, C. W., *Nature*, **153**, 377 (1944); **153**, 588 (1944); **156**, 39 (1945).

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Aphid Vectors of European Raspberry Viruses

THE failure in vigour and productivity of cultivated raspberries during the last decade in England, and more especially in the concentrated raspberry-growing districts of Scotland, has been due mainly to the spread and cumulative effect of a number of virus diseases. This has been amply demonstrated by the work of Harris[1,2] and our own unpublished work. A precise determination of the viruses concerned and of their interrelations and the development of remedial measures have, however, been severely handicapped by the absence hitherto of information on the natural vectors of the viruses concerned.

Insect transmission of the European raspberry viruses has long been suspected on the basis of evidence from combined field studies of insect fauna and disease spread[3]. Confirmation of these suspicions, provided by data from a series of experiments begun by one of us (C. H. C.) in 1944, is the reason for publishing this note.

The only aphid species of general occurrence on raspberries in Scotland are *Amphorophora rubi* Kalt. and *Aphis idæi* V.d.G. Exploratory experiments carried out in 1944 and 1945 demonstrated that both these species could act as vectors of viruses causing two distinct types of mosaic disease, whereas all attempts to effect transmission by means of jassid and thrips species proved negative. A series of more critical experiments carried out in 1946 have confirmed these findings and provided the data set out in the accompanying table.

Populations of aphids were allowed to feed, for the time intervals stated, on entire plants or, in the case of Series *A*, on detached leaves, of an apparently healthy stock of Lloyd George known to be carrying at least the Mosaic 2 virus or viruses of Harris[2]. The cultures were maintained under muslin sleeve cages from which large numbers of aphids were transferred to each of ten virus-free plants of the indicator variety Norfolk Giant similarly caged. The aphids were allowed to feed on these healthy plants for varying periods, up to 14 days, before being destroyed by fumigation.

Series	Infection feeding time on Lloyd George	Aphid spp.	
		A. rubi	*A. idæi*
A	12 hours	0/10*	0/10
B	3 days	1/10	1/10
C	7 days	2/10	1/10
D	14 days	2/10	2/10
E	21 days	0/10	2/10

* Numerators show numbers of plants infected; denominators show number of plants colonized with aphids.

The experiments were, of necessity, performed in non-insect-proof glasshouses, but, whereas symptoms of mosaic appeared in the indicator plants of Series *C* and *E* 24 days after the date of transfer, no such symptoms developed either on the twenty control plants or on the stock plants upon which the aphid cultures had originally been reared.

With one exception, Norfolk Giant plants on which *Amphorophora rubi* had fed developed symptoms only of Mosaic 2; while the six affected plants in the set of fifty to which *Aphis idæi* was transferred all developed symptoms of a distinct and hitherto undescribed disease provisionally named 'curly dwarf' (Harris and Prentice *in litt.*). The exceptional plant in the *A. rubi* series also developed curly dwarf. The presence, in the Lloyd George infector stock, of the viruses causing these diseases has since been confirmed by grafting to indicator hosts.

The results suggest that both aphid species require feeding periods longer than twelve hours to pick up the viruses causing these distinct symptoms, and also that at least *Aphis idæi* shows a marked degree of specificity in the viruses transmitted. The design of the experiments does not permit of any further deductions on the relations between the aphid vectors and the viruses they transmit.

So far, transmission has been achieved with difficulty; very large numbers of aphids have been employed except in the case of a subsidiary experiment using seedling plants raised from a Norfolk Giant × St. Walfried cross, where transmission of Mosaic 2 by *Amphorophora rubi* was effected by 25–50 aphids per plant. This finding is, however, in conformity with the slow rate of spread of mosaic diseases under field conditions.

A fuller account of these and cognate investigations will be published at a later date. The evidence here set out does, however, permit the conclusion that the common raspberry aphids, *Amphorophora rubi* Kalt. and *Aphis idæi* V.d.G. are capable of acting as vectors of certain raspberry viruses under Scottish conditions.

The investigation, of which this work forms a part, is financed by a grant from the Agricultural Research Council, to which our acknowledgments are therefore due.

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A. R. Hill

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Dundee. Sept. 1.

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Optimum pH and Temperature, and Energy of Activation of the Transamination between Glutamic Acid and Pyruvic Acid

In a previous paper[1] I stated that the process:

$$\text{glutamic acid} + \text{pyruvic acid} \underset{b}{\overset{a}{\rightleftharpoons}} \alpha\text{-ketoglutaric acid} + \text{alanine} \quad . \; . \; . \; . \; . \; (1)$$

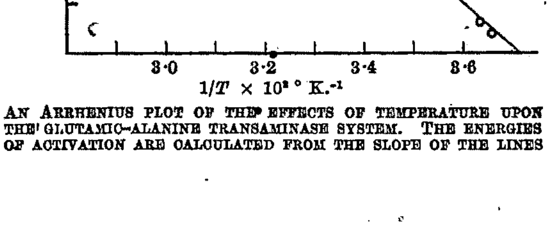
reaches an equilibrium through a first-order reaction according to the equation:

$$\log_e (1 - \alpha/\alpha_0) = -kt.$$

In this, k is the velocity coefficient, t the time measured in seconds, α the degree of reaction at the time t, and α_0 at the time $t = \infty$, when the equilibrium has been attained. In the temperature interval 15°–70° and at pH 7·5, $\alpha_0 = 0 \cdot 60$ for reaction (1a) and $\alpha_0 = 0 \cdot 40$ for (1b).

Using k as a measure of the strength of the enzyme (alanine–glutamic transaminase), it is possible to determine in an absolutely unambiguous way the relation between enzyme activity and pH or temperature.

The enzyme was prepared by extraction of minced ox hearts with 1/15 M phosphate buffer (pH 7·5). The liquid is pressed through a linen cloth and half saturated with ammonium sulphate. The precipitate containing the enzyme is filtered off, suspended in water and dialysed in a 'Cellophane' tube against running tap water. The undissolved residuum is centrifuged off and discarded. The solution is heated at 60° for 10 min. The heat-coagulated protein is centrifuged off and the clear supernatant liquid is used in what follows. The determination of k is carried out as previously described[1]. The concentration of substrate in the reaction mixture (enzyme + substrate + buffer) is 0·0167 M with regard to amino- and keto-acids.



An Arrhenius plot of the effects of temperature upon the glutamic–alanine transaminase system. The energies of activation are calculated from the slope of the lines

Using k as a measure of the enzyme strength, it appears that the reaction has a maximum of velocity at pH 7·5 in accordance with Kritzmann's result[2]. The velocity is very sensitive to changes in pH; altering pH from 7 to 7·5 increases k about threefold. In a similar manner the optimum temperature is found to be 75° C. In order to decide whether the enzyme reaction follows the Arrhenius equation, $\log_e k \times 10^5$ is plotted against the reciprocal absolute temperature ($1/T \times 10^3$) as shown in the accompanying graph. A sharp break in the relationship occurs at 34°. It is apparent that the reaction follows the Arrhenius equation accurately from 0° to 34° with an energy of activation of 17,475 cal., and from 34° to 70° with an energy of activation of 8,740 cal. Such a shift at a critical temperature has been reported previously with regard to other enzyme systems[3].

The energy of activation and Q_{10} for the alanine–glutamic transaminase system as reported by me earlier[1] is no longer relevant, as the temperature interval in which the two constants are computed (25–35°) includes the critical temperature.

S. Darling

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May 18.

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Visual Cells of the Guinea Pig

O'Day has pointed out[1] that his histological preparations provide definite evidence for the presence of cones in the retina of the guinea pig. I welcome this statement, although I have myself, as he indicated, relied on authors who have denied it. Occasionally one finds evidence for red modulators in the eye of the guinea pig (see, for example, Fig. 140, p. 281, of my recent summary[2]). Such modulators, I maintain, should be ascribed to cones if the histological differentiation of the cells into rods and cones is going to mean anything at all to retinal physiology. There are more of them in the eye of the rat. Since, however, some histologists deny the presence of cones in the eye of the rat (see ref. 2), and others refuse to accept them in the guinea pig, the physiologist must try to stand on his own feet.

I have suggested[2] that the red modulators in the eye of the rat are due to cones. But cones cannot be as important in the eyes of the guinea pig and the rat as in the retina of the cat. The latter has a very much greater number of the on/off-elements typical for cones (80 per cent); at least 36 per cent of the elements show a complete Purkinje shift with light adaptation. I have never found such Purkinje shifts in the eyes of rats and guinea pigs[2].

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Nov. 12.

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ROYAL SOCIETY MEDAL AWARDS, 1947

THE following is the substance of the remarks made by Sir Robert Robinson, president of the Royal Society, in presenting the medal awards for 1947 at the anniversary meeting on December 1.

Copley Medal

The Copley Medal is awarded to Emeritus Prof. G. H. Hardy in recognition of his distinguished contributions to mathematics [died December 1].

For many years G. H. Hardy has occupied an outstanding position among mathematicians in Great Britain, while his eminent services and original work have also been very widely recognized in other countries. In his memoirs and papers published with collaborators, especially J. E. Littlewood, are to be found the origins of the major developments of 'classical analysis' throughout the world in the years 1910–35.

Among the most influential and original of his works are those dealing with the Tauberian theorem for Cesàro summability (1910); the proof that the Riemann zeta-function has an infinity of zeros on the critical line (1914); the asymptotic formula for the number of partitions of an integer (with Ramanujan, 1918); the papers on Waring's problem and Goldbach's problem (with Littlewood, 1920, 1922); the paper in *Acta Mathematica* on Fourier series (with Littlewood, 1930). He has made important contributions to lattice-point theory, to the theory of integral equations, and (with Littlewood) to the theory of Diophantine approximation.

Lying in widely separated domains of analysis, all these papers contain fundamentally novel ideas which were the starting-points for new significant developments by Hardy and others. For example, a part of the distinguished work of Vinogradoff may justly be said to derive from that of Hardy. His influence has been exerted, not only by his publication of original work, but also through a long succession of pupils, many of whom are now well-known mathematicians. At a time when the vigorous treatment of analysis in university courses had still to win general acceptance, Hardy's enthusiastic advocacy and his inspiring lectures had a decisive effect. In addition, the appearance of his highly individual text-book "Pure Mathematics", helped to demolish finally the barriers between the British and Continental schools of mathematics.

It is impossible to characterize in a few sentences the achievement, so varied, and so abstruse, of the Copley Medallist for 1947, but in very ordinary words it may be said that Hardy saw clearly what were the most important tasks and problems lying before mathematicians; he had good judgment in selecting those which seemed ripe for attack, and he displayed the greatest skill and energy in their solution.

Royal Medals

A Royal Medal is awarded to Prof. C. N. Hinshelwood, for his outstanding researches in chemical kinetics.

Prof. Hinshelwood has brought a characteristic lucidity of mind and directness of approach to bear on the investigation of many classical problems presented by the course of chemical change. He has clarified these subjects to an extent which seems remarkable to those who recall the mystery which enshrouded them only a few years ago.

The acute suggestion of Lord Cherwell relating to the consequences flowing from the relative rates of formation and decomposition of an intermediate additive complex was taken up and extended by Hinshelwood. He predicted that on the basis of this theory certain apparently monomolecular reactions should follow a bimolecular law at low pressures. One example of the justification of this prophecy was found in the decomposition of acetaldehyde. This experimental verification of the hypothesis of intermediate complexes of definite life, and the new light shed on the mechanism of activation of molecules, are pillars of modern chemical kinetics. Hinshelwood has enlarged our knowledge of this subject by many other researches of great importance including those on the synthesis of water, a classical problem of seeming simplicity and real complexity, and those on the conditions of 'chain' reactions. His ingenious experimental methods, though characterized by a lack of unnecessary elaborations, have nevertheless always been able to provide accurate results.

It was a very original conception to apply the principles and methods of chemical kinetics to the growth of bacteria, and Hinshelwood has already made noteworthy progress in this field. The outcome has been to provide a new and more delicate assessment of the presence and activity of factors that influence growth at all stages under defined conditions.

During the War he carried out important researches on the adsorption of gases by charcoal, and on the preparation of suitable adsorbents for different purposes, ranging from gas-masks to the production of penicillin.

The brilliant exposition of chemical topics contained in Prof. Hinshelwood's books places contemporary chemists and students still further in his debt. His memorable addresses on the wider implications of chemistry made as president of the Chemical Society and on the occasion of the celebration of its centenary were generally acclaimed. Possessing enviable linguistic attainments, he has frequently been an 'ambassador of British science'. Recognizing these achievements we wish to honour Prof. Hinshelwood above all for his pioneering work in the laboratory and in the study, which has thrown so much light on the most fundamental processes of chemistry, the mode of interaction of molecules.

A Royal Medal is awarded to Dr. F. M. Burnet for his distinguished contributions to our knowledge of the viruses.

Dr. Burnet, director of the Walter and Eliza Hall Institute, at Melbourne, has made a series of extremely significant investigations of bacteriophages and viruses since 1925. In twenty-seven papers on the first topic he has made greater advances than anyone apart from d'Herelle. He has elucidated the phenomenon of lysogenesis or 'carrying' of a bacteriophage, active against other bacteria, by an organism which is itself apparently unaffected. He has shown how study, partly on a biochemical basis, of the range of activity of 'phages against various bacteria can be used to classify not only the 'phages but also the bacteria themselves. Other investigations have made an important contribution to our present ideas as to what bacteriophages are.

Since 1933 he has studied many viruses pathogenic for vertebrates. He has shown how psittacosis is endemic in wild Australian parrots, and has thrown light on the epidemiology of herpes and poliomyelitis. To modern workers he is best known for his development of several techniques for cultivating viruses in living chick embryos, and their application in immunological and other studies of viruses, especially influenza. He has written monographs on the use of chick embryos in virus research, on immunity to viruses, on influenza and on the nature of antibodies.

At present he is examining the agglutination of mammalian and avian red blood cells by a number of viruses and virus-products, and is thus throwing fresh light on the reactions taking place between viruses and the surfaces of susceptible cells. He has found that an enzyme produced by cholera vibrios has an action on blood cells which is quite similar to that of influenza viruses, and is capable of blocking the union between virus and susceptible cell. This discovery indicates one line of approach to the problem of the chemotherapy or chemoprophylaxis of virus infections.

Burnet has been active in many other fields; he has studied staphylococcal toxins and he was the first to make a formolized staphylococcal toxoid. He has demonstrated that a rickettsia is the cause of Australian *Q*-fever.

While his experimental studies have demanded close attention to detail, certain continuous threads have connected his interests. The breadth of his outlook and his philosophic attitude of mind are well exemplified in his fascinating book "Biological Aspects of Infectious Diseases" and in the more recent publication "Viruses as Organisms".

Davy Medal

The Davy Medal is awarded to Prof. Linus Pauling in recognition of his distinguished researches on molecular structure.

The unusual breadth of Prof. Pauling's scientific knowledge, his mastery of physics and mathematics in addition to chemistry, made him peculiarly fitted to apply quantum mechanics to problems of chemical valency bonds. In him, theoretical acumen and penetrating insight are associated with experimental skill of the highest order, and thus his theories were often tested after the devising of new physical techniques. This combination of theoretical and practical attainments is very remarkable at such a level in both aspects.

As a natural consequence of his catholic interests, Pauling's work has covered a very wide range of chemical structural problems. He has devoted much attention to line spectra and many other physical topics; but his most individual achievements are in the advance of molecular structure theory. In elucidating the fundamental structure of simple organic compounds he developed the method of localized pairs (atomic orbitals) to provide a theoretical treatment of the valency conditions of such molecules. By this introduction of orbital hybridization he gave the first theoretical account of the tetrahedral distribution of the valencies of the saturated carbon atom (1928). This was followed by the introduction of the quantum mechanical concept that the actual state of a molecule such as benzene should be represented as a resonance hybrid of several valency bond structures (1931). The application of this idea and the experimental verification of its structural implications in terms of increased stability and decreased bond distances greatly increased our understanding of aromatic and general chemistry. The calculus of the resonance theory of Pauling was the first to introduce a quantitative treatment of valency problems, and its effect has been felt far beyond the bounds of the experimental material.

In 1939 his extensive work was summarized in a great book "The Nature of the Chemical Bond", which will always be one of the classics of chemistry. Here we find a general classification of stubborn aspects of valency theory along with valuable tables of generalized and correlated data on resonance energy terms, bond distances and angles, and atomic radii.

Proceeding to apply his methods to the study of more complex molecular systems, Pauling has made important contributions to our understanding of the metallic bond; of the structure and mode of denaturation of native proteins; and of the mechanism of the fundamental reactions of immunology, that is, antibody formation, and the antibody–antigen interaction.

Prof. Pauling has earned our gratitude, not only for his personal services, great as those have been, but also because he has been a focus of activity and a constant source of inspiration to other workers.

Buchanan Medal

The Buchanan Medal is awarded to Sir Edward Mellanby for his services to medical science and in recognition of his outstanding researches on dietary factors.

The Buchanan Medal is awarded every five years in respect of distinguished services to the science or practice of hygiene in the direction either of original research, or of professional, administrative, or constructive work, without limit of sex or nationality. In each of these respects the award to Sir Edward Mellanby is surely one of the most appropriate that could be made. For some thirteen years he has devoted himself to the service of medical science and the national organisation of medical research. His personal research work, which has been continued right up to the present time, has been concerned mainly with problems of nutrition, and has had important results in the relation of diet to the public health.

Sir Edward's two most important contributions have been on the effects of deficiency of vitamin D and of vitamin A in the diet. He first showed that rickets was unquestionably due to the lack of a fat-soluble vitamin, since known as vitamin D, and he also demonstrated that other factors, dietary and general, such as lack of exercise, contributed to aggravate the condition. Quite recently he has shown that lack of vitamin A, in addition to the already recognized effects on general health, is capable of producing profound neurological disorders, owing to the mechanical effect of abnormal growth of bones around the foramina through which nerves leave the central nervous system. The knowledge which has been made available as a result of his investigations has played an important part in the feeding of the nation on scientific lines, in war, and in peace-time.

The study which he made of the effects of lack of iodine has thrown much light on the various forms of goitre, and especially on the hyperplastic and colloid forms: the former he showed to be caused by iodine deficiency, particularly in young animals, or in ante-natal states, while the latter is produced by the belated admission of iodine to such sufferers from the hyperplastic condition. The knowledge has been of value in connexion with the lack of iodine in the water and soil of some districts.

Mellanby's researches on the physiological effects of alcohol have also provided valuable knowledge concerning the effects of this substance as a constituent of the diet.

His most recent contribution has been to show that bread which is made from flour bleached by the 'Agene' process, that is, with nitrogen trichloride, can cause the condition in dogs known as canine hysteria.

As the secretary of the Medical Research Council, Sir Edward has proved himself a wise, strong and withal a helpful administrator.

Hughes Medal

The Hughes Medal is awarded to Prof. J. F. Joliot in recognition of his outstanding researches in nuclear chemistry and physics.

Prof. Joliot, director of the Nuclear Chemistry Laboratory of the Collège de France, was early concerned with investigations leading to the discovery of the neutron and with subsequent work on that particle. In 1932 he found that the very penetrating radiation emitted when beryllium is bombarded with alpha-particles was able to eject protons from hydrogenous material upon which it fell. This observation was followed up by Chadwick, who was able to show that the radiation consisted of the neutrons which he and Rutherford had sought for years.

In 1934 Joliot made a discovery of the utmost importance. He found that aluminium and other light-atom substances were rendered radioactive by bombarding them with alpha-particles. He showed that these radioactive products emitted positive or negative electrons and gamma-rays. By chemical methods he proved that the radioactivity produced was due to the formation of unstable isotopes of neighbouring elements; for example, in the case of aluminium, the active substance produced was an isotope of phosphorus. It was soon shown that the production of these artificially radioactive isotopes was possible by bombardment with other types of particle and that practically all the elements could be prepared in radioactive form. In this way Joliot founded an important development of modern 'tracer' technique and opened up a field of investigation of immense importance to physical, chemical, and biological science.

In 1939 Joliot and his co-workers observed that in the process of fission of uranium several neutrons are emitted. This important observation indicated the possibility of a chain process in uranium, and Joliot at once endeavoured to produce such a self-propagating reaction. With Halban and Kowarski he showed, in 1940, that if the fission neutrons were slowed down in heavy water a chain-reacting system could be produced. The practical success of the heavy-water 'piles' in the United States of America and in Canada is the outcome of these pioneering discoveries in the application of atomic energy.

In a great part of his work, Prof. Joliot has been closely associated with his wife, Prof. Irène Joliot-Curie.

SYNTHESIS OF PHOSPHOLIPIDS IN THE FŒTUS

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WHETHER fœtal lipids are derived primarily from the preformed maternal substances by placental transmission, or from synthesis within the fœtus, cannot yet be answered satisfactorily. Up to now, most investigators have been concerned with the placental transmission of fatty (and other) substances, and very little has been done to explore the possibility of synthesis of these compounds by the fœtus. Nielson[1] studied the permeability of the rat placenta to phospholipids with the aid of P^{32} and found that after the injection of the mother with inorganic phosphate, labelled with P^{32}, radioactive phospholipids could be isolated from the fœtuses within 2 hr. after the injection. When, on the other hand, an emulsion of phospholipids labelled with P^{32} was injected intravenously to the mother, the appearance of radioactive phospholipids in the fœtuses was very much delayed, and even then only small amounts were found. Nielson, therefore, concluded that the placenta does not transmit phospholipids and that these substances are readily synthesized within the fœtus. In my experience, when an emulsion of phospholipids is injected intravenously, so long as any of the excess phospholipid remains in the circulation, it always stays in the form of an emulsion. The only conclusion, therefore, that can be drawn from Nielson's work is that the placenta does not transmit emulsions of phospholipids; whether this is also true for the plasma phospholipids in the physiological state of dispersion remains an open question. In order to follow the experimental design of Nielson in the investigation of the sources of fœtal phospholipids, the mothers should be transfused with plasma containing labelled phospholipids. Up to now, the supplies of P^{32} in Great Britain have been small, and therefore this experiment, requiring relatively large amounts of the isotope, is not practicable.

There is, however, another possible way of attacking this problem. After the injection of a suitable dose of P^{32} in an inorganic form, the plasma phospholipids become labelled with this isotope. If fœtal phospholipids are derived from the preformed maternal substances only, then the radioactivity of fœtal phospholipids should never exceed the activity of the maternal plasma phospholipids. If, on the other hand, a rapid synthesis takes place within the fœtus, and if the transfer of inorganic phosphate from the mother to the fœtus is sufficiently rapid, then there might conceivably be a time when the activity of the fœtal phospholipids is greater than the activity of the maternal plasma phospholipids.

Pregnant rats, guinea pigs and rabbits were injected subcutaneously or intravenously with disodium hydrogen phosphate labelled with P^{32}. After varying intervals, the phospholipids were isolated from the maternal plasma, maternal liver, fœtal liver, fœtal carcass and viscera, fœtal placenta, and whenever possible from the fœtal plasma also, and their radioactivities compared. In several experiments, the inorganic phosphate of the tissues was precipitated as the ammonium-magnesium salt from a trichloracetic acid extract and its radioactivity measured

TABLE 1. RADIOACTIVITY OF TISSUE INORGANIC-P AND OF PHOSPHOLIPID-P RELATIVE TO THAT OF MATERNAL PLASMA PHOSPHOLIPID-P

Rabbit 138: 3·16 kgm., 26th day pregnancy, 4 hr. after intravenous injection of a single dose of P^{32} as Na_2HPO_4

Source	Specific activity in relative units	Activity of liver phospholipid-P as % of activity of tissue inorganic-P
Maternal plasma phospholipid-P	100	—
Maternal liver inorganic-P at the end of experiment	2570	—
Maternal liver phospholipid-P	405	15·76
Fœtal liver inorganic-P at the end of experiment	1098	—
Fœtal liver phospholipid-P	221	20·10
Fœtal placenta phospholipid-P	328	—
Fœtal plasma phospholipid-P	39·6	—
Fœtal carcass (without liver) phospholipid-P	45·3	—

also. The measurements of radioactivity were carried out with a Geiger-Müller counter.

The results were alike in all three species, and because more detailed experiments were carried out with rabbits, results of representative experiments obtained on this animal alone are shown. From Table 1 it is evident that the activity of the phospholipids extracted from the fœtal liver and fœtal placenta was much greater than the activity of the maternal plasma-phospholipids 4 hours after the injection of the mother with labelled phosphate. These two fœtal organs, therefore, appear to be sites of phospholipid synthesis. The activity of the fœtal carcass- and plasma-phospholipids, on the other hand, was much less than the activity of the maternal plasma phospholipids; and therefore it cannot definitely be decided from this and similar experiments whether these phospholipids were synthesized within the fœtus or derived from the mother by placental transmission. The low specific activity of the fœtal plasma phospholipids shows that the highly active lipids in the fœtal liver have been synthesized in that organ, and have not been transported from the fœtal placenta.

The observed radioactivity of phospholipids extracted from the tissues, after the injection of labelled phosphate into an animal, depends not only on the rate of synthesis of the lipid, but also on the abundance of the isotope in the inorganic phosphate fraction of the tissues. In the experiment shown in Table 1, the activity of the maternal liver phospholipid phosphorus was 15·76 per cent and that of the fœtal liver phospholipid phosphorus 20·1 per cent of the activity of the inorganic phosphorus in these organs. There are reasons to believe that this difference indicates that the rate of phospholipid synthesis is higher in the fœtal than in the maternal liver, the most active adult organ in this respect.

TABLE 2. RELATIVE SPECIFIC ACTIVITIES OF PLASMA- AND TISSUE-INORGANIC-P AND PHOSPHOLIPID-P IN MOTHER AND FŒTUS

Rabbit 148: 3·5 kgm., 24th day pregnancy. The radioactivity of maternal plasma-inorganic-P was maintained constant (to within ± 10 per cent) for 250 minutes by the repeated subcutaneous injection of P^{32} at 20–30 min. intervals

Source	Specific activity of Inorganic-P	Specific activity of Phospholipid-P	Activity of tissue phospholipid-P as % of activity of inorganic-P in the tissues
Maternal plasma	100	0·945	—
Maternal liver	30·72	2·48	8·07
Fœtal plasma	62·9	—	—
Fœtal liver	20·2	2·64	13·08
Fœtal carcass (without liver)	7·14	0·50	7·02
Fœtal brain	1·85	0·147	7·95
Fœtal placenta	30·65	4·34	14·20

In Table 2, results of a more detailed experiment are shown. The activity of the maternal plasma inorganic phosphorus was maintained constant for 250 min. The figures in this table give further emphasis to what has already been said (compare activities of phospholipids) and show, in addition, that the probable reason for the low activities of fœtal carcass- and brain-phospholipids is that the concentration of the isotope in the inorganic phosphate fraction in these tissues was very low. The activities of the fœtal carcass- and brain-phospholipid phosphorus were 7·02 and 7·95 per cent respectively of the inorganic phosphorus in these tissues; values not much lower than the figure for the maternal liver (8·07 per cent). These figures suggest by themselves that there is synthesis in these tissues also, at a rate comparable with that in the maternal liver.

TABLE 3. RELATIVE ACTIVITIES OF FŒTAL PHOSPHOLIPIDS 3 HR. AND 3 HR. 10 MIN. AFTER INJECTION OF LABELLED Na_2HPO_4 INTO RABBIT FŒTUSES 25 DAYS OLD

Rabbits 151 and 152

Source of phospholipids	Specific activity of phospholipids: 3 hr. after injection	Specific activity of phospholipids: 3 hr. 10 min. after injection
Maternal plasma	Inactive*	Inactive*
Fœtal liver	100	100
Fœtal viscera (intestines, kidneys, lungs and heart)	—	39·1
Fœtal carcass (without liver)	17	—
Fœtal brain	3·34	3·84

* That is, no activity could be detected in phospholipids that could be extracted from 15 ml. of plasma.

That phospholipid synthesis is taking place in all fœtal tissues was proved definitely by experiments in which the fœtuses were injected directly *in utero* with disodium hydrogen phosphate labelled with P^{32}. The mothers were given nembutal (three quarters full anæsthetic dose) and for the actual operation the anæsthesia was deepened with ether; after opening the abdomen, the labelled phosphate was injected with a fine needle through the uterine wall into the back of the fœtus. The abdominal incision was then closed. The experiments lasted 1–3 hr.; results of two are shown in Table 3. The fœtuses suffered no apparent ill-effects either from the injection or from the operation on the mother. By this technique it was possible to obtain high activities in the fœtuses and very low activities in the mother. In one experiment, for example, the inorganic phosphorus in 0·1 ml. of fœtal plasma gave 500 counts/min. and the same volume of maternal plasma, withdrawn at the same time, only 5 counts/min. above background. It is evident from Table 3 that the fœtal tissues examined all synthesize phospholipids. When the activity of the phospholipids in these experiments is expressed as a percentage of the activities of the inorganic phosphorus in the tissues, values are obtained which are comparable with those in experiments of the type illustrated in Table 2. This makes it highly probable that all fœtal phospholipids are synthesized within the fœtus.

The evidence presented, of course, indicates only that the phosphorylating step in phospholipid synthesis takes place in fœtal tissues, and it remains to be seen whether the other steps required in building up whole phospholipid molecules also occur.

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[1] Nelson, P. E., *Amer. J. Physiol.*, 135, 670 (1941–42).

CLASSIFICATION, BREEDING AND PRESERVATION OF THE POTATO

A SYMPOSIUM, at which recent investigations on the classification, breeding and preservation of the potato were discussed, was arranged by the Association of Applied Biologists and held in London on October 3.

The South American potatoes, their classification, affinities and value to the potato breeder were discussed by J. G. Hawkes. It was pointed out that breeders are turning more to the indigenous potatoes of the American continent in their attempts to solve problems of disease resistance and adaptation to new environments. The co-operation of the systematist, the cytologist and the geneticist is needed when dealing with the transference of the useful properties from the wild potatoes to the domestic varieties.

Mention was made of the potato-collecting expeditions in South America and especially of the British Empire Expedition sent out by the Imperial Agricultural Bureaux in 1939. An outline was given of the collection brought back by this latter expedition and the work in progress at the Empire Potato Station at Cambridge. Its use in conjunction with Empire potato breeders was also discussed. The distribution of the wild potatoes and their varied type of habitat indicate their possible use in breeding new varieties suited to climates where the potato of commerce will not at present grow.

An outline followed of the method of classification of the wild species into groups, and the valuable economic characters to be found among them. Resistance to blight, frost, viruses and Colorado beetle, together with a form of immunity to potato root eelworm, are to be found among the wild species. Some cultivated potato species are frost-resistant; others possess a very short dormancy and ability to grow at higher temperatures; others, again, are promising in respect of vitamin C and protein contents.

Many of the valuable characters are to be found in potatoes only distantly related to the cultivated varieties of Europe. Studies on chromosome numbers and on the 'crossability' of the various species are giving more exact information on their relationships and helping in the transference of the valuable disease resistance from the wild potatoes into our domestic varieties.

W. Black dealt with blight in potato breeding. Potato seedlings bred from the immune wild species *Solanum demissum* have been tested for resistance to the common strain of blight, A, and two new strains, B and C. Although B and C are more virulent than A, they differ qualitatively from each other. A fourth strain, D, appears to be slightly less virulent than C and to differ from it quantitatively. The fungus is considered to exhibit plasticity and it is thought that its virulence can be built up or modified by the degree of resistance of the host plants on which it is grown.

Studies on the inheritance of resistance indicate that, with the A, B and C strains, blight resistance behaves as a dominant, appearing to be controlled by four major genes, Ra, Rb, Rc and R_3, conferring immunity from strain A, B, C and all three respectively. It is also considered that minor genes may be present which act as modifiers in the resistant varieties and determine the degree of susceptibility in the susceptible varieties. In genetical studies the ratios obtained always show an excess of recessives. This is thought to be due either to chromosome homologies leading to multivalent production, or more probably to the presence of incompatibility factors contributed from the wild parent.

Tests were described for ascertaining the genetical constitution with regard to blight immunity in parent varieties, and evidence was presented that suggested an increase in the virulence of the B strain of blight.

In the afternoon session, A. R. Wilson spoke on methods of potato storage in North America, basing his remarks on information gained during a tour under the auspices of the Agricultural Research Council in consultation with the Department for Scientific and Industrial Research and the National Farmers' Union.

Various types of storage building were described, ranging from an ordinary farm basement to a refrigerated and air-conditioned store built specially for the purpose. Partially or completely sunk stores, depending for their heat insulation chiefly on the soil banking around them, are capable of several modifications. Some are of the deep bin type with bins 18–25 ft. deep—to be found chiefly in the colder areas—whereas others are of the shallow (8–12 ft.) bin type found in the warmer areas.

Surface stores, usually of the shallow bin type, are heavily insulated, especially on the roof, to prevent sudden fluctuations of temperature and water condensation with consequent dripping on to the tubers. Various types of bins with different methods of partitioning and detachable front boards for unloading were detailed.

Ventilation and air circulation seem to be very variable in these stores, and are either of the gravity or of the forced-draught type, with the air circulating through the potatoes or passing in the floor, back and sides of the bins—the so-called 'shell' type. On the evidence available, it would appear that the shell type is the slower though more thorough method of cooling. Methods of bulk transport and of temperature control were treated also. Permanent storage accommodation has a future in Great Britain, but the American methods need careful trial here before they are adopted.

A survey of Scottish seed tuber problems was given by C. E. Foister, dealing chiefly with the methods used in attempting to reduce tuber diseases. Mention was made of the certification scheme, which distinguishes three grades for freedom from virus and trueness to type. A registration scheme is also in force to stimulate the production of varieties immune or resistant to disease. Stress was laid on methods of handling potatoes; it is thought that most farmers pay insufficient attention to dressing out diseases and abnormalities in the tubers before dispatch.

The potato work at the Seed Testing Station at Corstorphine was outlined, and the tests for blight resistance on seedlings raised by private breeders were mentioned. It is believed that there is approximately a 75 per cent correlation between foliage and tuber resistance to blight. The co-operative scheme of dry-rot investigations was also mentioned. Since there are no immune varieties at present known, it is hoped that resistance to dry-rot may be found among the South American potatoes in the Empire Potato Collection. Similarly, no varieties immune to skin spot or to scab are known in Britain, and here again the Empire Potato Collection may prove of value.

Mention was made also of black-leg, blind tuber, and a possible outbreak of potato stem eelworm in Scotland this year.

A. E. W. Boyd described some recent results of dry-rot research, indicating the very severe losses in the variety Doon Star with this disease, and the enormous decrease in the acreage grown during the last few years. It was pointed out that dry-rot is caused by the wound parasite *Fusarium cœruleum*, and that the degree of infection is directly proportional to the percentage of wounding. The parasite can also enter through lesions of powdery scab. Rough handling of the potato bags and riddling of the tubers has a very marked effect in increasing the incidence of the disease, and road transport also increases infection with previously riddled tubers.

Methods of control were dealt with in some detail. Dipping in an organic mercury preparation or 1 per cent formalin gives a good measure of control if done at lifting time, though the disadvantages of wet treatments at the busy harvest season are obvious. Thymol at the rate of 5–6 oz. (made up to 10 lb. with kaolin) per ton of potatoes has been found to be the best all-round method of control. Occasionally, however, the thymol exhibits a marked phytocidal effect on the tubers, though generally only a part of each tuber is damaged and the remainder can grow and yield normally. Application of thymol both at lifting and riddling was recommended, since these are the times of maximum damage when infection generally takes place. In the discussion which followed, the merits of the proprietary compound 'Fusarex' were discussed, together with its advantage in delaying sprouting.

J. G. Hawkes

RHEOLOGY OF MINERALS

ANNUAL CONFERENCE OF THE BRITISH RHEOLOGISTS' CLUB

THE annual conference of the British Rheologists' Club was held at Hulme Hall, University of Manchester, during September 11–13. The inaugural address was given by Prof. Harold Jeffreys, of Cambridge, who spoke on the strength of the earth; Dr. Markus Reiner, of Jerusalem, was in the chair. Prof. Jeffreys pointed out that in geophysics it is usual, as a first approximation, to assume that most of the earth is a perfectly elastic solid (transverse elastic waves from earthquakes travel freely through it to a depth of nearly half the radius, corresponding to five-sixths of the volume). Decisive evidence was given that the earth is strongly condensed towards the centre, which consists probably of liquid iron. Prof. Jeffreys discussed geological strains associated with fracture and continuous flow, and spoke on experimental work done on the behaviour of rocks under large stresses. The effective rigidity can be reduced to a half by long loading; but the fact that the Pyramids still stand is evidence that the strain tends to a finite limit. Treating the problem of fracture by dynamical methods, it can be shown that fracture can occur under the pressures existing at 650 km., the deepest earthquake focus recorded, a fact against the many theories that postulate a finite viscosity under stress differences however small. The crushing strengths of granite and basalt, as measured in the laboratory, are about 10^9 dynes/cm.^{2}. Sir George Darwin, studying a harmonic distribution of load resembling a set of parallel mountain chains, found that the stress difference would reach a maximum at a depth $\frac{1}{2}\pi$ of the wave-length and be equal to e^{-1} times the range of load; for the Himalayas, this would suggest stress differences of the order of 10^9 dynes/cm.^{2}, and the great ocean deeps could be supported by similar strengths. It is known that there are widespread disturbances of gravitational fields that are not noticeably correlated with height; these imply genuine variations of mass per unit area, and therefore of load on the lower layer, which cannot be in a hydrostatic state.

A paper on the mechanical properties of soils and their relation to engineering practice was read by A. W. Skempton, University reader in soil mechanics and assistant professor at the Imperial College of Science and Technology, London. The mechanical properties of sands, gravels, silts and clays—referred to as soils in civil engineering—are of importance in many practical problems, including foundations, earth dams, retaining walls, roads and runways. An analysis of many practical problems was given, together with a quantitative description of the main classes of soils. This was followed by an outline of our present knowledge on the shear strength characteristics, with particular reference to clays, and the various problems in which shear strength plays an essential part. The consolidation of clays was also considered, together with some of the results which have been obtained in recent researches on the electro-physical properties of clays and silts.

In the morning session of September 12, Prof. Jeffreys in the chair, papers were read by Prof. F. C. Phillips, Herdman professor of geology in the University of Liverpool, on preferred orientation of minerals and the mechanism of rock flow, and by Dr. G. M. Lees, chief geologist, Anglo-Iranian Oil Co., Ltd., on the formation of salt domes and the flowage of rock salt. Prof. Phillips in his paper pointed out that the primary flow of igneous rocks, consolidating from a melt, may frequently be traced in a linear or platy parallelism of phenocrysts or included fragments in flow layers. Unconsolidated sediments, too, may show primary flow structures in the sense that they may flow by reason of their high water content. Rocks are found folded to a degree varying from gentle flexures to the recumbent overfolds, or nappes, of mountain systems, such as the Alps, with amplitudes of many miles; these have responded to compressional stress by flowing in the sense that they have acquired a permanent deformation without loss of cohesion. Prof. Phillips discussed in detail the actual means by which rock flow is achieved, and gave evidence of dimensional and lattice orientation of individual fabric elements. The fabric of fine-grained rocks such as slates can be studied suitably by X-ray methods. The fact that in most deformed rocks some degree of preferred orientation is present suggests that at some stage a new mechanism of translation gliding operates which allows further deformation without continued rotation. This movement is similar to that in glacier motion and has been ascribed variously to the displacement of rigid masses along shear planes, to local melting and regelation, to intergranular movement and to translation gliding of the crystals.

There is good evidence for translation gliding in minerals such as mica, and twin-gliding in calcite, but there is still no certain evidence of the real mechanism by which the apparent plasticity of quartz is achieved; an artificial orientated quartz fabric has been obtained by shearing according to Larsen and Bridgman.

Dr. G. M. Lees in his paper continued the subject of rock flow by referring to the formation of salt domes in Persia. He illustrated his talk with numerous diagrams of geological sections of the Persian oilfields showing sinuous anticlines 100–200 miles in width, bent and folded with little fracture or faulting although the folds of limestone are 2,000 ft. thick. There was considerable discussion on the mechanism of flow in the salt masses.

There were two papers on viscometry: one by Dr. R. Schnurmann, chief physicist, Manchester Oil Refinery, Ltd., on the effect of shearing stress on the viscosity–temperature dependence of lubricating and hydraulic oils; and another, on industrial viscometers, by Dr. E. W. J. Mardles and Mr. A. G. Ward, speaking on behalf of the committee of the British Rheologists' Club in its report on the subject. Dr. Schnurmann described in detail recent experiments at high rates of shear on the shear breakdown of polymer solutions, the degradation being traced to the fissure of long-chain molecules by mechanical means. In the Committee's report on industrial viscometry, a short survey of conditions of rheological measurements, of methods and of viscometers, penetrometers, etc., was made. The principles which should govern routine measurements for non-Newtonian systems were given briefly, and it was considered that all instruments should be reviewed in the light of these principles.

Concern was expressed about the inaccuracy of some standard viscometers, in particular, orifice viscometers with diameter of orifice not much less than the length. Apart from difficulties of dribbling, lack of temperature control and lack of calibration against a master cup, the times of flow may have little or no relation to viscosity values. With some penetrometer results, it had frequently been assumed that it is possible to interpret them by the classical law of Stokes, assuming the behaviour was Newtonian; this was found not to be the case with greases, paints and thickened liquids.

In addition to visits to the Manchester Oil Refinery and to the engineering laboratories of the Metropolitan-Vickers Electrical Co., Ltd., an evening was devoted to an informal discussion opened by Dr. K. Weissenberg and Mr. S. M. Freeman (Shirley Institute, Manchester), who demonstrated some rheological phenomena that had come to light since the last conference. They dealt specially with anisotropy-time effects using elastic liquids and elastic solid/gas systems. The rheogoniometer was used to indicate relaxation in different directions.

E. W. J. MARDLES

FUNCTION OF THE LYMPHOCYTE

THE function of the lymphocytes in the mammalian body has long been the subject of conjecture. Now, at last, one definite function, and a very important one, has been ascribed to them, on impressive evidence. It appears that the lymphocytes synthesize and afterwards liberate into the blood the normal γ-globulin of the plasma and also the various antibodies which appear in the blood in immunity reactions. The antibodies are known to be simply specific modifications of γ-globulin. Furthermore, it has been shown that this liberation of γ-globulin by the lymphocytes, and in fact the whole activity of the lymphoid tissue, are controlled by one of the hormones of the adrenal cortex. At a conference on lymph held by the New York Academy of Sciences in April 1945, W. E. Ehrich (*Ann. New York Acad. Sci.*, **46**, 823; 1946) and A. White and T. F. Dougherty (*ibid.*, p. 859) presented the important contributions which they have made to this new knowledge of the lymphocyte.

It has long been known that about 200 million lymphocytes per hour enter the blood stream. They must, therefore, be removed from the blood at a corresponding rate, but where or how this occurs has been a mystery. It has now been shown that, as first suggested by Heiberg in 1922, a large proportion of the lymphocytes return to the germinal centres of the lymph nodes, where they undergo a process of 'dissolution'. It is not quite clear how the lymphocytes get back to the germinal centres, but it seems probable that they emigrate directly from the blood vessels which supply the lymphoid tissue, possibly from certain venules of peculiar structure which are to be found there. The process of dissolution involves the shedding of cytoplasmic fragments by a process of budding and also, in the case of many lymphocytes, complete cellular destruction, the nuclear remains being phagocytosed by the macrophages of the germinal centre. In the process of dissolution, γ-globulin, which is presumably synthesized by lymphocytes as a normal cytoplasmic component, is liberated and is carried away in the lymph stream to the blood.

The germinal centres are thus both the birthplace and graveyard of the lymphocytes, and their main function seems to be to manufacture and carry a store of γ-globulin which is liberated and made available to the body on their dissolution. γ-Globulin is thus one of the few plasma proteins, possibly the only one, not manufactured in the liver. The antibodies of the blood, which appear during the development of immunity to foreign proteins, bacteria and bacterial toxins, are known to be specific modifications of normal plasma γ-globulin, differing only in the configuration of the molecule and the arrangement of the constituent amino-acids. It is thought that, in an immunity reaction, the lymphocytes manufacture the specific antibody in place of the normal γ-globulin, and therefore liberate the antibody instead of γ-globulin when they disintegrate in the germinal centres.

Hitherto it had been supposed that the antibodies were manufactured by the cells of the reticulo-endothelial system. This theory, due to Metchnikoff, rested chiefly on the observation that reticulo-endothelial blockade reduced antibody formation. In order to reconcile this fact with the newer knowledge, Ehrich supposes that the antigen must first be ingested and partly digested by the reticulo-endothelial cells, the digestion products then stimulating the lymphocytes to form the specific antibody. It would seem unlikely, however, that antigen could be digested far, if at all, without losing its specific antigenic properties. White and Dougherty have shown that the hormone of the adrenal cortex stimulates the dissolution of lymphocytes in the germinal centres and so increases the liberation of γ-globulin and antibodies into the blood, and also, incidentally, reduces the total volume of lymphoid tissue in the body. A single injection of adrenal cortex hormone or of the adrenotrophic hormone of the pituitary gland causes a marked increase of lymphocyte destruction in the germinal centres, a lymphopænia and a rise in plasma globulin, the changes reaching a maximum about twelve hours after.

If an animal was first immunized to an antigen (sheep's red cells) and then some months later, when all the antibody had disappeared from the blood, injected with adrenal cortex hormone, the antibody reappeared in the blood in considerable amount. The therapeutic implications of this experiment are obvious and will no doubt be explored. It has also been shown that the total amount of lymphoid tissue present in the body is determined and controlled by the adrenal cortex, and the normal age involution of the lymphoid tissue (including the thymus) is ascribed to an increasing activity of the adrenal cortex, which is in turn due to an increasing activity of the anterior pituitary. The pituitary-adrenal mechanism for the release of γ-globulin and antibodies can be activated experimentally in a number of ways, for example, by hæmorrhage, heat, cold, X-rays, foreign proteins, injection of benzene or arsenite. From another point of view the lymphocytes of the body represent a considerable store of protein which can be rapidly released by the pituitary-adrenal mechanism in states of emergency.

Reports of a repetition of this work have not yet been published, and confirmation or otherwise of the somewhat surprising results will be awaited with interest. O. A. TROWELL

MINERAL PRODUCTION OF CANADA

"THE Canadian Mineral Industry in 1945", published by the Bureau of Mines, Ottawa (1946, pp. 103), contains reviews of the various metals, industrial minerals and fuels produced in the Dominion during 1945, and gives particulars in each case of sources of supply, uses, prices and tariffs, and figures for production, exports and imports. In order of value (stated in millions of dollars) the chief products are: aluminium (133·6); gold (103·8); coal (67·6); nickel (62); copper (59·3); zinc (33·3); platinum group (26·7); asbestos (22·8); lead (17·3); cement (14·2); petroleum (13·6); lime, limestone and marble (13·2); natural gas (12·3); sand and gravel (10·6); clay and clay products (8·3); silver (6); salt (4); peat (2); pyrite and sulphur (1·9); gypsum (1·8); silica (1·5); barite (1·3); magnesitic dolomite and brucite (1·3); granite (1·1); sodium sulphate (0·9); selenium (0·7) and cadmium (0·6). No corresponding figure for iron ore is given, but it is interesting to note that production, negligible only a few years ago, has recently increased enormously, and is expected soon to equal the requirements of the Canadian iron and steel plants. The Helen Mine, north of Lake Superior, and the Steep Rock Mine, west of Port Arthur, each produced more than half a million tons during 1945 and have very substantial reserves.

The temporary disappearance of magnesium from the above list is a symptom of war-time over-production, large stocks of the metal and its alloys having already been accumulated in Ontario. It may be a surprise to many to find aluminium at the head of the list. Although there is no bauxite in Canada, the Canadian aluminium industry is the second largest in the world, being exceeded only by that of the United States. The favouring factors are the low costs of hydro-electric power at points where the necessary raw materials can be cheaply assembled.

Canada's dominating position as a source of nickel is well known; it remains at about 80 per cent of the world total. Despite the drastic reduction in munitions manufactures, the many new uses found for nickel during the War, as in radar and extended utilization of nickel-bearing steels, are expected to provide an expanding market. Canada continued to be one of the leading exporters of copper, and to maintain its position—gained from the U.S.S.R. in 1934—as the leading producer of the platinum and palladium group of metals. Coal production is down a little and petroleum by as much as 15 per cent.

Production of oil from the Turner Valley field has been decreasing since 1942. The search for new fields in Alberta has so far been disappointing, but six producing wells have been completed in Saskatchewan, which appears as a small producer for the first time. The development of natural gas resources has been more successful, especially in Alberta. The new gas field recently discovered in Ontario beneath the floor of Lake Erie was brought into production by means of wells put down a mile from the shore.

ANALYTICAL GEOLOGY

THIS is the name given by A. B. Vistelius to the application of statistical analytical methods to numerical geological data and the subsequent interpretation of the results in the light of significant geological facts. In a series of five short articles*, he applies this method to the study of the porosity of rocks belonging to the oil-bearing strata of Permian age in the Transvolgian region of the U.S.S.R. The original data consist of a number of records of the coefficients of porosity (y) of rocks, taken in a number of bore-holes at a certain depth (x) below a definite stratigraphical horizon. Plotting the coefficient of porosity against depth, Vistelius obtains broken-line diagrams which are smoothed out so as to give continuous curves. It is then discovered that for all the bore-holes of the region these curves correspond to a definite formula, the equation of which is originally given as

$$y = m + nx + \exp\,(a_1x + b_1)\cos\,(\omega_1x - \varphi_1) + \exp\,(a_2x + b_2)\cos\,(\omega_2x - \varphi_2),$$

and then reduced to a general serial expression of the type

$$y' = \sum_{i=0}^{k} \exp\,(a_ix + b_i)\cos\,(\omega_ix + \varphi_i)$$

$$\text{where } k \leqslant 3.$$

Then the coefficients a_i, b_i, ω_i and φ_i are calculated for each bore-hole and the analogous coefficients for different bore-holes are compared and plotted on the geographical map by means of isopleths (contour lines corresponding to equal numerical values).

The isopleth maps, showing the regional distribution of the numerical values of the coefficients of the generalized formula, are then compared to other maps such as strato-isohyps maps or isopachyte (lines of equal thickness of a bed) maps of the region, and it is discovered that the isopleth maps of certain coefficients are analogous either to structural isohyps maps or isopachyte maps. This suggests that the distribution of porosity in a sedimentary complex obeys not only a certain periodic law, as expressed by the general formula, but is also linked up with the general geological structure of the region and is therefore related to the geological history of the sedimentary complex. The coefficient of periodicity (ω) appears to be especially significant, and the isopleth maps of this coefficient can be easily correlated with either the structural maps or the isopachyte maps. According to whether the members of the equation contain the minimum, maximum or intermediate value of ω, they are called micro-, macro- or meso-rhythms.

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* Vistelius, A. B., *Compt. Rend.* (*Doklady*) *Acad. Sci. URSS.*, **44**, No. 1, 27 (1944); **49**, No. 1, 44 (1945); **49**, No. 7, 531 (1945); **54**, No. 6, 519 (1946); **55**, No. 3, 241 (1947) (Russian text).

To Vistelius all this suggests that porosity is closely related to the processes of deposition and epigenesis (cementation and leaching), and so can be used as a measure of what he calls the 'phase differentiation' of the sedimentary complex, the phases in this case being the solid phase (mineral components of rocks) and the liquid and gaseous phases (infilling the pore space). If the empirical equation of the vertical distribution of porosity is compared with the equation expressing the normal law of errors, or rather the function of distributed probabilities, one is able to get an estimate of the magnitude of the secondary processes (epigenesis) as compared with the magnitude of the primary processes (sedimentation). This is achieved by the construction of isopleth maps for kurtosis and skewness, which provide a sensitive method of discovering the distribution of 'fossilized processes'.

All this work is still in its pioneering stage and as presented can be appreciated only by geologists well versed in modern statistical methods. It is rather difficult to evaluate the significance of isopleth maps for equation coefficients when these are compared with structural contour maps (isohyps or isopachytes). In spite of this difficulty, this work appears very interesting and important. There is a suggestion that this method may have a wider applicability to geological problems in which the immediate data do not allow any direct correlation or deduction. The practical importance of the application of statistical methods to geology may be considerable. In the case discussed by Vistelius, the porosity of the rocks has a direct bearing on the distribution of reservoir beds in an oilfield, but it is not difficult to find many other instances of work of economic value in which statistical methods may have an application. Such are, for example, water supplies, distribution and grade of coal in coalfields, and other similar problems. S. I. TOMKEIEFF

ELEMENTARY PARTICLES AND THE GEOMAGNETIC FIELD

RECENTLY J. Barnóthy[1] has proposed an explanation of the elementary particles (protons, electrons, etc.) in terms of serial universes, each enclosed in one of higher order. The elementary particles of our universe are universes of a lower order; our universe is an elementary particle in a higher universe. The universes are three-dimensional curved ones enclosed in a four-dimensional space; that of an elementary particle has a two-dimensional intersection with our universe, which delimits a region excluded from the latter. Mass in an elementary universe becomes imaginary mass ($\sqrt{-1} \times$ mass) when viewed from ours; the gravitational attraction between two imaginary masses is a real electrostatic force. The spin of an elementary universe gives parts of its mass a velocity greater than c; this makes the imaginary mass acquire real linear and angular momentum. Nuclear forces in our universe are the counterparts of cosmical repulsions in the elementary universe. Protons and electrons arise from Einstein universes of negative and positive curvature; a neutron is formed by the combination of a proton and another particle arising from a de Sitter universe.

Barnóthy expresses these general ideas in a quantitative form. Like Eddington, by some of whose ideas he has been profoundly influenced, he derives an impressive list of theoretical values of fundamental constants, in good agreement with the experimental values. One must add that, again as with Eddington, it is often difficult to trace the interconnexions between different parts of his argument. In particular, the mechanism by which internal properties of a micro-universe react on our universe is far from clear.

Barnóthy claims to explain the proportionality between magnetic moment and angular momentum of sun and earth, to which Blackett and Babcock have recently directed attention. [Barnóthy's work was not suggested by that of Blackett and Babcock; a preliminary account of his ideas, dated September 13, 1946, was received by *Nature* last year, but was not regarded as sufficiently explicit to warrant publication. EDITORS.] He asserts that protons and neutrons possess, besides their real mass, an imaginary mass 643 times the electron-mass, and this imaginary mass behaves like an electric charge. The rotation of such a charge would produce terrestrial and solar magnetic fields of just the observed order of magnitude; but the suggestion is not at present satisfactory, since such a charge would produce a formidable electrostatic field, and Barnóthy declines to consider this field for the present. T. G. COWLING

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[1] Hungarian Institute for Meteor. and Terr. Mag., Papers on Terrestrial Magnetism, No. 2 (1947).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, December 15

ROYAL PHYSICAL SOCIETY OF EDINBURGH (at the Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh), at 5.15 p.m.—Symposium on "The Species Concept".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. T. B. L. Webster: "Three Interpretations of Greek Vases" (Presidential Address).*

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. D. A. Harper: "The Technology of some New Condensation Rubbers".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at Norwood Technical Institute, Knight's Hill, London, S.E.27), at 7 p.m.—Microchemical Exhibition and Demonstration (organised by Mr. J. T. Stock).

Tuesday, December 16

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Colin Colahan: "Australian Art".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. F. Hepner: "Communications and History".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. A. Fraser Roberts and Dr. Eliot Slater: "Genetics, Medicine and Practical Eugenics".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Sir Charles Inglis, F.R.S.: "Mathematics in relation to Engineering, with Special Reference to a Recent Paper by the Lecturer on Shear Stress Determination".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. G. Window: "Glass Equipment in the Chemical Engineering Industries".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting; at 6.15 p.m.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (joint meeting with the LONDON SECTION of the INSTITUTION OF THE RUBBER INDUSTRY, in the York Room, Caxton Hall, Westminster, London, S.W.1), at 6.30 p.m.—Dr. D. V. N. Hardy: "Terylene and its Early Development".

TEXTILE INSTITUTE, MIDLANDS SECTION (joint meeting with the COVENTRY TEXTILE SOCIETY, at the Technical College, Coventry), at 6.45 p.m.—Mr. R. Meredith: "X-Rays in relation to Textiles".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at the Royal Technical College, Glasgow), at 7 p.m.—Dr. C. H. Giles: "Modern Methods of Colorimetric Analysis".

TEXTILE INSTITUTE, LANCASHIRE SECTION (at 16 St. Mary's Parsonage, Manchester), at 7 p.m.—Mr. L. L. Preston and Mrs. A. N. Thomas: "Radio Frequency Heating and Infra-Red Drying".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Scientific Films (arranged by Mr. H. Ogden and Mr. F. Hill).

Wednesday, December 17

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Papers.

CHEMICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. John Read, F.R.S.: "Chemical Personalities a Century Ago".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5 p.m.—Films.

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. Kompfner: "The Travelling-Wave Tube".

BRITISH RHEOLOGISTS' Club (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Papers on "War-time Rheological Investigations for the Services".

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (in Room 104, College of Technology, Leicester), at 7 p.m.—Mr. R. R. Clegg: "Textile Drying Technique".

INSTITUTION OF THE RUBBER INDUSTRY, SOUTHERN SECTION (joint meeting with the SOUTHERN SECTION of the PLASTICS INSTITUTE, at the Polygon Hotel, Southampton), at 7.15 p.m.—Mr. S. B. Turner: "Expanded Plastics".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Science and Fuel" (to be opened by Prof. D. M. Newitt, F.R.S., and Dr. Martin Ruhemann).

Thursday, December 18

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. H. Fitch: "The Tin Mines of Pahang Consolidated Co., Ltd.".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. G. K. Batchelor: "Progress and Difficulties in the Theory of Isotropic Turbulence".

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Second Annual General Meeting; at 5 p.m.—Discussion on "Insulating Materials and Methods for Use at Low Temperature" (to be opened by Prof. F. E. Simon).

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Prof. A. Thom and Mr. W. G. A. Perring: "The Work of the High Speed Tunnel".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Discussion on "Infra-Red Spectra and Molecular Structure" (to be opened by Dr. H. W. Thompson, F.R.S.).

Friday, December 19

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir Edward Appleton, F.R.S.: "Geomagnetism and the Ionosphere" (Fourth Charles Chree Address). (Fellows of the Royal Astronomical Society are invited.)

INSTITUTE OF INDUSTRIAL ADMINISTRATION, MANCHESTER CENTRE (in the Reynolds Hall, College of Technology, Manchester), at 7.15 p.m.—Sir Francis Joseph, Bart.: "Management and Recovery".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST to St. James's Hospital—The Medical Officer of Health, Public Health Department (Hospitals Administration Section), 12 Market Buildings, Vicar Lane, Leeds 1 (December 20).

TECHNICAL ASSISTANT (preferably a woman) for Cod Liver Oil (Poultry) Standardization Laboratory, for work mainly connected with routine biological tests of vitamins and other substances—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (December 20).

MACHINERY RESEARCH OFFICER for duties in connexion with the use and development of mechanical appliances in forestry—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (December 20).

LECTURERS IN (a) PHYSICS with subsidiary Mathematics, Ref. A.435/47A, (b) Electrical and Mechanical Engineering, Ref. D.378/47A, (c) Mechanical Engineering Drawing, Ref. C.733/47A, by the Ministry of Supply School of Electronics, Malvern—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (December 23).

PRINCIPAL RESEARCH OFFICER, and a SENIOR RESEARCH OFFICER, in the Research Unit of the Colonial Insecticides Committee at Porton, Salisbury—The Under-Secretary of State (Research Department), Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (December 29).

ASSISTANT ANALYST (male) in the County Chemical Laboratory, Stafford—The Clerk to the County Council, County Buildings, Stafford (December 29).

LECTURER IN MATHEMATICS—The Registrar, University College, Leicester (December 31).

ASSISTANT DIRECTOR—The Director, The University Observatory, Cambridge (December 31).

LECTURER IN CHEMISTRY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (December 31).

SENIOR LECTURER (or LECTURER) IN PHYSICS in Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 31).

LECTURER IN AGRICULTURAL ENGINEERING in Canterbury Agricultural College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (December 31).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER IN THE DIVISION OF FOOD PRESERVATION AND TRANSPORT, Homebush, N.S.W.—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1467 (January 3).

SENIOR RESEARCH OFFICER IN THE DIVISION OF AERONAUTICS, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1478 (January 3).

LECTURER (with qualifications in electronics) IN THE FLUID MOTION LABORATORY—The Registrar, The University, Manchester 13 (January 31).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary of University Court, The University, Glasgow (March 31).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS and allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

TURNER AND NEWALL RESEARCH FELLOWSHIPS IN ENGINEERING, INORGANIC CHEMISTRY or PHYSICS, or any allied science—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

SOIL LABORATORY ASSISTANT by the Government of Northern Rhodesia for the Public Works Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18396.

RESEARCH ASSISTANT IN BIOCHEMISTRY—Prof. E. J. King, Postgraduate Medical School of London, Ducane Road, London, W.12.

LECTURER IN MATHEMATICS—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1.

TECHNICIAN (Grade B) for research laboratory of biochemistry and physiology in relation to mental disorder—The Physician Superintendent, Runwell Hospital, Wickford, Essex.

LABORATORY TECHNICIAN for physiological laboratory in the Department of Zoology—The Secretary, University Museum, Oxford.

SENIOR LABORATORY STEWARD IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER IN PHYSICS—The Clerk, Northern Polytechnic, Holloway, London, N.7.

PHYSICIST, PHYSICAL CHEMISTS (2), an ORGANIC CHEMIST, and a TEXTILE TECHNOLOGIST—The Acting Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1.

TECHNICAL INDEXER (woman) in the PLANT AND ANIMAL PRODUCTS DEPARTMENT—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

LABORATORY TECHNICIAN (Grade C) IN THE PHYSICS DEPARTMENT—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

PHYSICISTS OR PHYSICAL CHEMISTS, and TECHNICAL ASSISTANTS with some experience, preferably, in the clay industries—The Director of Research, British Refractories Research Association, Mellor Laboratories, Hanley, Stoke-on-Trent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Caribbean Commission: Committee on Agriculture, Nutrition, Fisheries and Forestry of the Caribbean Research Council. Crop Inquiry Series, No. 3: Grain Crops in the Caribbean. Pp. xi + 125. (Port of Spain: Caribbean Research Council, 1947.) [273

Hypnotism, a Psychic Malpractice. Pp. 28. (Los Angeles and London: Theosophy Co., n.d.) 25 cents. [273

New Zealand: National Art Gallery and Dominion Museum. Report of the Board of Trustees for the Year ended 31st March 1946. Pp. 14. (Wellington: Government Printer, 1946.) 6*d*. [273

Transactions of the San Diego Society of Natural History. Vol. 11, No. 3: An Undescribed Race of the Mangrove Warbler from Baja California, Mexico. By A. J. van Rossem. Pp. 49–52. (San Diego, Calif.: San Diego Society of Natural History, 1947.) [273

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1946. Pp. iii + 113. (Washington, D.C.: Government Printing Office, 1947.) 30 cents. [313

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SCIENTIFIC RESEARCH AND PUBLIC EXPENDITURE

THE statistical survey of scientific and technical research in British industry recently made by the Industrial Research Secretariat of the Federation of British Industries, while admittedly incomplete, is a valuable supplement to the survey of expenditure on research and development which formed the subject of the Third Report of the Select Committee on Estimates for the Session 1946–47 (132–1. London : H.M. Stationery Office, 1947. 6*s.* net). The Federation's report is based on the 471 replies received to about nine hundred copies of a questionnaire circulated to industrial firms known or thought likely to be carrying out research. It is estimated that the survey covers some seventy-five per cent of the industrial research effort of Great Britain, although probably not more than fifty per cent of the firms carrying out research. On this assumption the total annual expenditure by industry on research and development within its own establishments is of the order of thirty million pounds, which represents about two thirds of one per cent of the total annual value of British manufacture.

This figure may be compared with that of £5,442,000 obtained from an earlier survey by the Federation and based on returns from 566 firms in 1938 ; but it is more pertinent to set it against the national estimated expenditure of £69 millions analysed in the report of the Select Committee on Estimates. The estimate for the Department of Scientific and Industrial Research for 1947–48 amounts to £3,118,289, or about ten per cent of the expenditure by industry itself ; but in addition it is estimated that other Departments are expending £1,500,500 on industrial research. The vote for Post Office research amounts to £750,000, for agricultural and fisheries research to £2,150,925, for medical research to £710,850, for research in the Dominions and Colonies to £538,825. In addition to miscellaneous grants for scientific investigation amounting to £70,560, account should also be taken of the expenditure by the universities on scientific research. This is of fundamental importance to the State as well as to industry, but it is difficult to obtain even an approximate idea of its magnitude. Expenditure on teaching cannot, of course, easily be separated from that on research, and the Select Committee estimates that of the present vote of £11,875,000 in aid of the universities, something less than £3,500,000 is for science, technology and agriculture. Part of the expenditure of just over £2 millions on medical and dental education will be for research, and there are also capital grants of probably not less than £1,800,000 ; but it would be rash to put the nation's expenditure on fundamental research as reaching anywhere near £5 millions, at least on these figures.

What overshadows all these sums, however, is the expenditure of £60,351,000 on research and development for the Admiralty and the Ministry of Supply, which is more than double the total estimated research expenditure of the whole of British industry. The Select Committee refrains from detailed comment as it proposes to deal with the problem of expenditure on defence research in a later report; but there is a *prima facie* reason for questioning whether the present distribution of expenditure on research and development is that most to be desired in the light of civil and military needs and national resources at the present time. The diversion of at least a third of this effort from defence purposes to civil research has been urged by the Association of Scientific Workers; but without the detailed returns supplied to the Select Committee, which it was considered undesirable to publish, it is not easy to judge whether a diversion of such magnitude would be desirable.

What is imperative is that the nation's expenditure on fundamental research, upon which defence no less than industrial development alike depend, should be used to the best advantage. There can be little doubt that our first concern should be, as Sir Henry Dale urged at Dundee, to promote the extension of fundamental knowledge, and build up again our scientific capital on which the needs of war have drawn so heavily. It is vital that our academic leaders of research, men with ideas and inspiration, should lack neither disciples, assistants, nor equipment. In urging this, Sir Henry Dale was thinking largely of the diversion of scientific minds from creative research to administrative work; and the present shortage of scientific man-power makes it important that due regard should be had to this danger, all the more because our war experience has demonstrated that the field in which the scientific worker can usefully operate extends far beyond that of the laboratory where he normally pursues his business.

That point was well made by Sir Edward Appleton in his A. D. Little Memorial Lecture* at the Massachusetts Institute of Technology in November 1946, when he indicated that, as emphasized in the Barlow Report, the Government order of priorities is now: universities and fundamental research; civil research (Government and industrial); and defence research. What needs to be remembered first, however, in this connexion, is that the limitations on expansion of fundamental research are not primarily financial but those of man-power. It was made clear in the evidence received by the Select Committee on Estimates that lack of money is not the difficulty holding up the pursuit of profitable new lines of research at the present time: the principal needs are for men and accommodation.

These two needs are closely linked, and both are bound to be affected by the Government's policy of priorities and of the restriction of capital expenditure due to the economic crisis. The Select Committee emphasizes that, while it may be open to question whether the allotment to pure research and to scientific teaching is adequate to secure the twin objects of gaining natural knowledge, which provides the foundation for the whole structure of applied science, and of providing the required output of trained research workers, the evidence suggests that the allocation for the current year is probably as much as can be usefully and economically absorbed. This problem is raised, and also the further question whether the expenditure on defence research represents an equitable distribution between civil and military needs; and on the adequacy of the rough estimate of 21 per cent of national expenditure on research for industrial research, no comment is made.

On that point an appended memorandum from the Department of Scientific and Industrial Research gives a little further information. Of the present vote, £942,000 represents grants to research associations, a figure which it is estimated will reach £1·million when the expenditure of the Department reaches its full post-war level of £4,035,000. Of the firms replying to the questionnaire from the Federation of British Industries and expending more than £1,000 per annum on research, ninety per cent possess their own separate research laboratory or department and thirty per cent carry out research in their own production department; while available estimates indicate that half the firms contemplate a twenty-five per cent increase of qualified research staff by the end of 1947 and a comparable further increase between 1948 and 1950.

These figures alone attest the importance of precise surveys of man-power requirements in relation to the expansion of the universities and colleges of technology, as was indicated recently in these columns (see *Nature*, November 29, p. 742). The memorandum from the Department of Scientific and Industrial Research, however, directs attention to the third factor in the situation, on which the Select Committee also comments. The Department of Scientific and Industrial Research, in addition to its primary responsibility for promoting and organising scientific work with a special view to its application to trade and industry, has also a duty to carry out scientific research within its scope required by other Departments of State. The memorandum indicates the provision being made for the discussion of common problems necessary for the most effective co-ordination; one responsibility of the new central intelligence group of the Department will be to make themselves generally familiar with what is going on in university and Government research organisations and, so far as possible, with the needs of industry, and then to effect such cross-fertilization as they can.

On the industrial side, the Federation of British Industries, through its Industrial Research Secretariat, is already doing much to promote the general exchange of scientific and technical information, and the inquiry indicated that most firms are satisfied with present arrangements. The Select Committee on Estimates, commenting on the dangers of overlapping and waste of effort in the present administrative organisation, emphasizes the value and need of a first-class system of liaison at all levels and the greatest possible interchange of information not only on results, but also on projects. It was satisfied that, in general, improvements in the existing organisation are being made as weak spots are revealed, and since these matters are under consideration by the Defence Research Policy Committee and the Advisory Council on Scientific Policy, it makes no further comment.

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* Science, Government and Industry. By Sir Edward V. Appleton. (Inaugural of the Arthur Dehon Little Memorial Lectures at the Massachusetts Institute of Technology, at Cambridge, Massachusetts, November 19, 1946.) Pp. 38. (Cambridge, Mass.: Massachusetts Institute of Technology, 1946.)

The Select Committee agrees with the opinion, which Sir Edward Appleton expressed at the British Commonwealth Scientific Conference last year, that it is far too early to decide what the ideal Government organisation for research should be, and the machinery for fostering scientific effort must remain for many years in a state of active development. That, however, does not exclude the need for closer study of the whole question of the organisation of scientific and industrial research in Great Britain, and indeed is a reason for further trial and experiment with the forms of institution best likely to achieve our purposes. There is general agreement, both in Great Britain and in the United States, that fundamental research is seldom a proper field for Government expenditure and that Government assistance is best given indirectly, through block grants to universities, research institutes and even individuals; but even here there may be room for inquiry as to whether there is in Britain a sufficiency of research institutions of the range and type to ensure that all branches of science are adequately covered. While the urgency of the present need for more and more production makes it essential to drive existing institutions to the utmost, the general unrest following a great war nevertheless provides both the right atmosphere for experiment with new ways of approach and the incentive to extract from each everything that can be of value for the future.

SYNTHETIC RUBBER

Butalastic Polymers

Their Preparation and Applications; a Treatise on Synthetic Rubbers. By Frederick Marchionna. Pp. vii+642. (New York: Reinhold Publishing Corporation, 1946.) 8.50 dollars.

THE development of synthetic rubber is one of the outstanding achievements of chemical industry in recent years. The chronicler of the story of this achievement is, however, faced with a multiplicity of difficulties. A comprehensive account must include, first the manufacture of the monomer, second the polymerization of the monomer, and third the fabrication and properties of a wide variety of articles made from rubber. The first part is a matter of large-scale industrial catalytic chemistry where the essential techniques are already well established in other fields of chemical engineering. The second is based on scientific principles, but is also compounded of much empiricism because there has not been time to go into these principles in an adequate manner so that the mechanism of polymerization is fully understood. The third is rubber technology applied to materials which have usually turned out to be rather more difficult to work with than natural rubber. Further, developments have mainly occurred in the United States, Germany and the U.S.S.R., and there has naturally been no interchange of information between these countries. Even if there had not been a world war, it is extremely doubtful whether the operators in these respective countries would have divulged the 'know how' regarding these processes so that an author could write a critical summary of the present-day position.

Dr. Marchionna has therefore had to face very considerable difficulties in writing an up-to-date account of the subject. The book was written before much information became available through the Allied teams of investigators sent to Germany and before the vast amount of work done for the rubber research programme in the United States began to appear in the scientific literature. There was thus only available to the author a considerable volume of earlier published work on the attempts made to synthesize rubber-like materials and a host of patents relating to the possible processes for the manufacture of monomer, for the polymerization of monomers and for the working up of the rubbers so produced; but of course with little guidance as to their real worth or economic practicability. In view of this awkward state of affairs, it is impossible to prepare a critical account of the various phases of the subject or even to give a personal opinion of the relative merits of competing processes or the various types of rubber now commercially available.

The contents of the book are restricted to what the author conveniently terms butalastic polymers, that is to say, synthetic elastomers in which the repeating unit was originally a diene. The volume is divided into three parts. The first deals with laboratory and technical methods of making isoprene, dimethyl butadiene, butadiene and halogen derivatives of dienes. Although butadiene is now regarded as the most important diene, the space devoted to it is perhaps a little disproportionately small. Part 2 is devoted to the problems involved in polymerization. Here the emphasis is mainly on the methods found empirically for diene polymerization, and there is no general account of polymerization from the kinetic point of view. Again this is reasonable, because diene polymerization has not yet yielded to accurate kinetic methods in view of the many complications that arise, especially in emulsion or sodium polymerization. Unfortunately, the lack of published information has precluded a detailed description of the processes currently used in the United States. Part 3 describes the technology of synthetic rubber, dealing with the coagulation of the emulsion and the incorporation of the usual rubber-compounding agents. Then there are sections dealing with all the usual applications of rubber in industry, special note being paid to the properties of synthetic as contrasted with natural rubber. There are comprehensive indexes to the book, which is well produced and excellently printed.

This, then, is the first comprehensive attempt to give a balanced and connected account of an industry which started many years ago, developed very slowly indeed and did not really come into its own until war compelled a tremendous amount of scientific and technological effort to be brought to bear in order to make certain that synthetic rubber would, in fact, be a practical proposition. Dr. Marchionna has attained success in a very difficult task. Any shortcomings which the book possesses are in the main due to the information not being available. It is to be hoped that when a second edition is required the war-time experiences will be incorporated, so that the reader can then discover what indeed are the scientifically and economically satisfactory ways of making and manipulating synthetic rubber.

H. W. MELVILLE

BIOLOGICAL SIGNIFICANCE OF NUCLEIC ACID

Nucleic Acid

(Society for Experimental Biology Symposia No. 1: Published for the Company of Biologists on behalf of the Society for Experimental Biology.) Pp. vii+290+18 plates. (Cambridge: At the University Press, 1947.) 35*s.* net.

IN 1914 Walter Jones began the preface to his monograph on nucleic acids with the words, "The nucleic acids constitute what is possibly the best understood field of Physiological Chemistry . . ." That was then a tenable point of view; but twenty years later it would have been absurd. There are fashions in everything, including biochemistry, and nucleic acids went largely out of fashion or were swamped by the growth of our knowledge of proteins, oxidation mechanisms and the other processes that characterized the development of biochemistry in the 1930's. The boom–slump–boom cycle is, however, not confined to economics, and a nucleic acid boom is now upon us. Much new knowledge of the intrinsic properties and biological behaviour of the nucleic acids has been gained during the past few years; but there seems to have been a disproportionate flood of review articles, conferences and symposia. Stocktaking is valuable, but what is now needed in cytochemistry is more stock rather than more surveying.

The present volume gives the text of nineteen papers delivered at a symposium in Cambridge in 1946. The first articles deal with the chemical and physico-chemical properties of nucleic acids and nucleotides, and in them emphasis is placed on the large body of pure assumption that has in the past done duty for knowledge in the field. The late Prof. J. Masson Gulland and his colleagues survey the structural evidence that can be derived from degradation experiments, and point out that the abandonment of the tetranucleotide structure greatly increases the theoretical possibilities of isomerism among the nucleic acids. Evidence on structure is also given in Lythgoe and Todd's brief but lucid description of their extensive series of nucleotide syntheses. Kalckar describes new techniques for the microanalysis of purines by ultra-violet absorption, and gives some of the metabolic conclusions gained with them.

A thoughtful critique of the validity of many cytochemical methods, by Danielli, makes a good introduction to the more biological part of the symposium. Brachet and Caspersson present much evidence that regions or times of intense protein synthesis are correlated with a high nucleic acid content. Although each individual piece of evidence is not by itself wholly convincing, the accumulated mass is most impressive. Two other articles stand in interesting contrast. With pleasing exuberance, Darlington speaks of "nucleic acid as the molecular midwife of all reproductive particles" but, while re-writing cytology, gives no hint, in this article, of the technique and observations on which his conclusions are based. Stedman proceeds more cautiously and continues his valuable attempt to convince cytologists and geneticists that there is more in the nucleus than protamine or histone and nucleic acid. There is perhaps a danger that a new dogma may be built up if the unfractionated protein that can be extracted from all the nuclei that have been studied is called 'chromosomin'. That other proteins are present is obvious; that these proteins are sufficiently uniform in chemical type to deserve a name is arguable.

The printing and format of the book, which appears to be the first of a new series, are good; but it is a pity that the titles of papers have been put at the head of both left- and right-hand pages. It would have been helpful to have the author's name on one side. It is also a pity that such a high price had to be charged for a work which, although useful, is essentially ephemeral.

N. W. PIRIE

NOAH'S NIGHTMARE

Built Before the Flood

The Problem of the Tiahuanaco Ruins. By H. S. Bellamy. Revised and enlarged edition. Pp. 192. (London: Faber and Faber, Ltd., 1947.) 21*s.* net.

TIAHUANACO is an important site in South American archæology, and although it is not the only one, it has something about it which, like Glastonbury, stimulates the imagination of the uncritical, who tend to exalt it above all others. Here are some facts which must be borne in mind in considering it in relation to the subject as a whole. Not only its famous stone ruins but also its pottery belong to a very characteristic and easily recognized style. Their distribution in the Andes is restricted to the neighbourhood of Tiahuanaco itself, but on the coast a closely related style in pottery and textiles, little later than the culmination of the style in the Andes, is widespread. This is later than the well-known Mochica culture of the north coast, now dated with some certainty at *c.* A.D. 1000. When due allowance has been made for the time taken for Tiahuanaco influence to spread from the Andes to the coast, this shows that some time late in the first millennium is a reasonable estimate for its date. In the central and south parts of the coast, pre-Tiahuanaco cultures, earlier than the Mochica but still datable within the first millennium A.D., have yielded abundance of perfectly preserved textiles and other fragile and perishable materials in shallow graves, owing their very existence to continuous drought since they were buried. In the extreme north of Chile, it has been proved that the relation between land and sea cannot have altered more than about 15 metres at the outside (in the sense of a rise of land) since the arrival of pre-pottery man, long before any sign of Tiahuanaco influence.

The contention of this book is, briefly, that Tiahuanaco was built "certainly not less than a quarter of a million years ago", when a satellite preceding the moon dominated the heavens, and that it was overwhelmed by a great "girdle tide" which this satellite raised in the equatorial regions shortly before its disintegration. These ideas are based on the speculations of an Austrian named Hoerbiger, and it is claimed that the carvings on the monolithic gateway at Tiahuanaco constitute a calendar which fits in with his scheme. That we are not told how the older fragile remains on the coast survived an inundation of some 14,000 ft. of water and other catastrophic happenings is a consequence of the failure to consider a site in its context, which is frequent in this sort of writing.

The age ascribed to the ruins makes them contemporary with part of the European palæolithic period, when it is most unlikely that man, even at that lowly stage of development, had reached any part of the American Continent. On the other hand, the idea that a satellite approached the earth and disintegrated, and that the moon was 'captured', all in Pleistocene times, is unlikely to commend itself to men of science. In view of the startling contradiction between Mr. Bellamy's conjectures and the geological time-scale, it is lost labour to follow him through the tortuous paths of his interpretation of the carvings on the Tiahuanaco gateway. This has given rise to divers interpretations—it has even been claimed that it has something to do with the Old Testament—but there is no reason whatever why it should have been a calendar.

This book first appeared in 1943, and it was reprinted in 1944. That there should now be a "new revised and augmented edition", little altered except for a six-month shift in certain signs and the addition of twenty-seven pages of astronomical explanation by another author, provokes the suggestion that its vogue may be due to the hardness of the times which drives men to seek escape in fantasy.

G. H. S. BUSHNELL

EVOLUTION ON GALAPAGOS

Darwin's Finches

By David Lack. Pp. x + 208 + 9 plates. (Cambridge: At the University Press, 1947.) 21*s*. net.

THE theories of Darwin, and particularly those propounded in the "Origin of Species", are subjects of evergreen interest both to laymen and to biologists, and it is constantly worth while to examine and re-examine them in the light of the newest knowledge. To-day it can be said that they have stood the test of years of antagonistic criticism and of more than a generation of precise biological research, and have re-emerged so triumphantly that Prof. R. A. Fisher has recently spoken of a renaissance of Darwinism. It is therefore of special interest to read Mr. Lack's account of the latest expedition to what is perhaps the most important region visited by Darwin, the Galapagos Islands, and to learn more of the peculiar fauna of that place. What Darwin himself once said is still true: "The natural history of these islands is eminently curious, and well deserves attention".

The Islands are oceanic, and their colonization by land animals appears to have been haphazard and of rare occurrence. To-day the main ecological niches are fully occupied, but by most unusual species. The present account concerns in particular the four genera and fourteen species of birds which have become known as Darwin's finches. It is presumed that they have all evolved from a common stock, a small group of immigrants from the American mainland, and that some of them, experiencing no competition but their own from that time onwards, have undergone unique modifications of structure and habit. Some of them, the ground finches, retained the seed-eating habit, but others, the tree finches, became insectivorous. Of the whole series, the most extraordinary are the woodpecker finch and the warbler finch. Had the niches now occupied by these two birds been already filled by a true woodpecker and a true warbler, it is suggested that such development could never have taken place.

The first lesson which the Islands teach is the great variety which can develop in a small virgin country from a severely restricted beginning, a lesson which is repeated there by many other animals and by the plants. A second is the paramount importance of geographical isolation for species formation. Not only has it been necessary that the colonists should be cut off from their parent stock, but the theory is also advanced that each of the various finch species must have arisen in the isolation of one or other of the Islands and later extended its range. To-day, where they meet, the species persist only because they have come to occupy different ecological niches, and this in turn must have tended to increase their specialization. In contrast, the only one of Darwin's finches which is present on Cocos Island has remained a single species. The situation of Cocos ensures almost complete isolation from the mainland, but being a single small island it offers no chances of isolation within its borders.

Mr. Lack's restatement and development of the problem of Darwin's finches is admirably done. The material summarized, the reviews which are given of past and present theories, as well as the individual views expressed by the author, are all highly stimulating and valuable, and there is an extensive bibliography. The style is pleasant, the printing is excellent, and although the photographs are not up to present-day standards, the illustrations are adequate. It is a book which will be of great interest to all those, amateur and professional, who are intrigued by the problems of the origin of species.

W. S. BULLOUGH

INTRODUCTORY BIOLOGY

Biology for Medical Students

By C. C. Hentschel and Dr. W. R. Ivimey Cook. Pp. xii+752. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 25*s*. net.

IN the fourth edition of this widely used text-book the authors have taken the opportunity of considerable revisions of both the text and the illustrations. This applies particularly, so far as the text is concerned, to the botanical part; fewer changes and additions have been made in the zoological section, though there, too, the alterations are extensive.

The botanical part of this text-book has now grown to a well-rounded introduction to botany, which in scope might indeed be of use to a first-year science student; plant physiology has been extensively treated, and it was the aim of the authors to lay in this way the foundations for a later study of human physiology. The zoological part covers fully the requirements of the first-year medical student.

Criticism concerns chiefly the illustrations. Though a great number of the photographs are excellent, the quality of the diagrams varies considerably. Illustrations of the same organ in the three vertebrate types under discussion (for example, the inner ear, Figs. 255, 277 and 305, or the heart, Figs. 240, 267, 293 and 294) are not comparable and make a comparative appreciation by the student very difficult. Some of the drawings (for example, Fig. 268 or Fig. 300) are reduced too much and the many labelled details can only cause confusion; and the student will find some drawings of the chick's embryology very difficult to understand.

But in spite of these blemishes the new edition will continue to be a useful guide to the medical student in his first-year work.

A. S.

Theory of Lie Groups, I

By Claude Chevalley. (Princeton Mathematical Series.) Pp. xii + 217. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1946.) 20*s.* net.

IN recent years great advances have been made in our knowledge of the fundamental structures of analysis, particularly of algebra and topology, and an exposition of Lie groups from the modern point of view is timely. This is given admirably in the book under review, which could well have been called "Lie Groups in the Large". To make such a treatment intelligible it is necessary to re-examine from the new point of view such subjects as the classical linear groups, topological groups and their underlying topological spaces, and analytic manifolds. Excellent accounts of these, with the study of integral manifolds and their constructions in the large, are given in the earlier chapters. In Chapter 4 we come to the definition of an analytic group and its underlying manifold, and to the introduction of the important concept of a Lie algebra associated with an analytic group. A Lie group is then defined as a locally connected topological group related in a certain way to some analytic group; from this it follows that the concept of Lie algebra can be used freely when dealing with Lie groups. Chapter 5 contains an account of Cartan's calculus of exterior differential forms and its application to the theory of Lie groups. The final chapter is concerned with compact Lie groups, and after a brief consideration of the general theory of representations it is proved, among other things, that every representation of a compact Lie group is semi-simple.

The style of writing, though very condensed, is clear, and the printing is excellent. The notation is that of the modern school, with 'union' ($\cup$) and 'intersection' ($\cap$) in place of the older 'sum' and 'product' of sets. (A misprint has unfortunately interchanged the symbols $\cup$ and $\cap$ in their definition on p. xii.) The author promises a second volume, to be mainly concerned with semi-simple Lie groups.

A. G. WALKER

Animal Nutrition

By Prof. Leonard A. Maynard. (McGraw-Hill Publications in the Agricultural Sciences.) Second edition. Pp. xviii + 494. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 25*s.*

THIS is one of the very few books which deal adequately with the fundamentals of the biochemistry and physiology of nutrition and with the applications of this knowledge to the feeding of farm animals. Since the first edition was published some nine years ago, much of the newer knowledge of nutrition has emerged, and this has meant extensive alterations in the sections on amino-acid, vitamin and mineral nutrition. In his preface, the author points out that owing to the limited opportunity which was enforced by war and its aftermath, it has been impossible to take account of the results of recent research in foreign countries, because the data have either remained unpublished or the journals containing them have not reached his desk. The student is warned by the author that he should not thereby gain a distorted picture of the progress of our knowledge of this very important field of physiology and chemistry. The present volume takes us up to the end of March 1946.

It is difficult to single out any particular parts for special comment, but the chapter on mineral deficiency is especially well treated, and the chapters on feeding experiments contain one of the best reasoned discussions on the pros and cons of the paired-feeding technique. In the author's view this method would appear to find its largest usefulness in comparisons in which food consumption is not markedly restricted by the conditions imposed, and in which the measure is in terms of the specific effect of the nutrient under study, instead of the more general measure of increase in weight. It is considered that there are many problems concerning which the use of separate experiments of both *ad libitum* and controlled feeding will give much more information than either procedure alone.

The chapters on growth, reproduction, lactation and work production are likewise excellent. In its clarity and brevity this work has few equals.

D. P. CUTHBERTSON

Photoelectric Cells

By Dr. A. Sommer. (Methuen's Monographs on Physical Subjects.) Pp. viii + 104. (London: Methuen and Co., Ltd., 1946.) 5*s.* net.

DR. SOMMER is well known for his work on photo-electric cells, and in this monograph he collects the basic work done by himself and others between 1931 and 1945. While there have been excellent texts on the industrial applications of photo-electric devices, there appears to be no review of the theoretical and research work since about 1934, so we are grateful to Dr. Sommer for his work and his bibliography. He is here concerned solely with photo-emissive cells. Commencing with Hertz, Planck and Einstein, he outlines the theory of emission, and shows how the number of materials useful as photo-emitters is strictly limited by ionization energy and work function, as well as physical properties. He then deals with the relationship of the wave-length of the incident light, the resulting emission, and the effect of gas in the enclosure. The manufacture of photo-cathodes is then outlined, and also the way in which they can be used for practical applications. Of great value is his critical table outlining the suitable types of cells for established technology, such as photometry, sound-film reproduction, picture-telegraphy, and television.

L. E. C. HUGHES

City Region and Regionalism

A Geographical Contribution to Human Ecology. By Robert E. Dickinson. (International Library of Sociology and Social Reconstruction.) Pp. xv + 327. (London: Kegan Paul and Co., Ltd., 1947.) 21*s.* net.

WHILE this book is not directly about planning, it deals with matters and conceptions that are essential to any far-sighted planning schemes. Human ecology, as the relation of society to the area in which it lives, is a difficult but most important study and one that is too often overlooked in schemes of administration. The spatial relations of human society is a study that has received too little attention in Great Britain. The city is a regional centre of a larger or smaller area, and its function as such is an important condition in delimiting regions within any country. Some cities weld together larger areas than others and size is not a necessary criterion of this function. Mr. Dickinson deals mainly with the town or city as a regional capital, but has also a good deal to say on the possible delimitation of regions in the United States, France and England and Wales. The book merits close attention.

EVIDENCE FOR THE EXISTENCE OF NEW UNSTABLE ELEMENTARY PARTICLES

By Dr. G. D. ROCHESTER
AND
Dr. C. C. BUTLER
Physical Laboratories, University, Manchester

AMONG some fifty counter-controlled cloud-chamber photographs of penetrating showers which we have obtained during the past year as part of an investigation of the nature of penetrating particles occurring in cosmic ray showers under lead, there are two photographs containing forked tracks of a very striking character. These photographs have been selected from five thousand photographs taken in an effective time of operation of 1,500 hours. On the basis of the analysis given below we believe that one of the forked tracks, shown in Fig. 1 (tracks *a* and *b*), represents the spontaneous transformation in the gas of the chamber of a new type of uncharged elementary particle into lighter charged particles, and that the other, shown in Fig. 2 (tracks *a* and *b*), represents similarly the transformation of a new type of charged particle into two light particles, one of which is charged and the other uncharged.

The experimental data for the two forks are given in Table 1; H is the value of the magnetic field, α the angle between the tracks, p and Δp the measured momentum and the estimated error. The signs of the particles are given in the last column of the table, a plus sign indicating that the particle is positive if moving down in the chamber. Careful re-projection of the stereoscopic photographs has shown that each pair of tracks is copunctal. Moreover, both tracks occur in the middle of the chamber in a region of uniform illumination, the presence of background fog surrounding the tracks indicating good condensation conditions.

Though the two forks differ in many important respects, they have at least two essential features in common: first, each consists of a two-pronged fork with the apex in the gas; and secondly, in neither case is there any sign of a track due to a third ionizing particle. Further, very few events at all similar to these forks have been observed in the 3-cm. lead plate, whereas if the forks were due to any type of collision process one would have expected several hundred times as many as in the gas. This argument indicates, therefore, that the tracks cannot be due to a collision process but must be due to some type of spontaneous process for which the probability depends on the distance travelled and not on the amount of matter traversed.

TABLE 1. EXPERIMENTAL DATA

Photograph	H (gauss)	α (deg.)	Track	p (eV./c.)	Δp (eV./c.)	Sign
1	3500	66·6	*a*	$3 \cdot 4 \times 10^8$	$1 \cdot 0 \times 10^8$	+
			b	$3 \cdot 5 \times 10^8$	$1 \cdot 5 \times 10^8$	−
2	7200	161·1	*a*	$6 \cdot 0 \times 10^8$	$3 \cdot 0 \times 10^8$	+
			b	$7 \cdot 7 \times 10^8$	$1 \cdot 0 \times 10^8$	+

This conclusion can be supported by detailed arguments. For example, if either forked track were due to the deflexion of a charged particle by collision with a nucleus, the transfer of momentum would be so large as to produce an easily visible recoil track. Then, again, the attempt to account for Fig. 2 by a collision process meets with the difficulty that the incident particle is deflected through 19° in a single collision in the gas and only 2·4° in traversing 3 cm. of lead—a most unlikely event. One specific collision process, that of electron pair production by a high-energy photon in the field of the nucleus, can be excluded on two grounds: the observed angle between the tracks would only be a fraction of a degree, for example, 0·1° for Fig. 1, and a large amount of electronic component should have accompanied the photon, as in each case a lead plate is close above the fork.

We conclude, therefore, that the two forked tracks do not represent collision processes, but do represent spontaneous transformations. They represent a type of process with which we are already familiar in the decay of the meson into an electron and an assumed neutrino, and the presumed decay of the heavy meson recently discovered by Lattes, Occhialini and Powell[1].

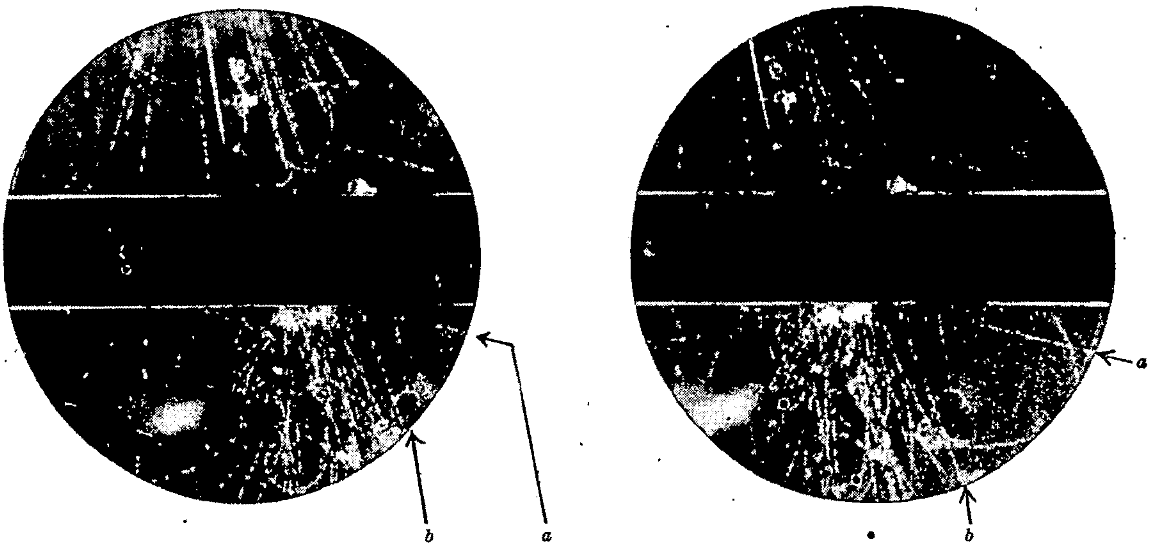

Fig. 1. STEREOSCOPIC PHOTOGRAPHS SHOWING AN UNUSUAL FORK (*a b*) IN THE GAS. THE DIRECTION OF THE MAGNETIC FIELD IS SUCH THAT A POSITIVE PARTICLE COMING DOWNWARDS IS DEVIATED IN AN ANTICLOCKWISE DIRECTION

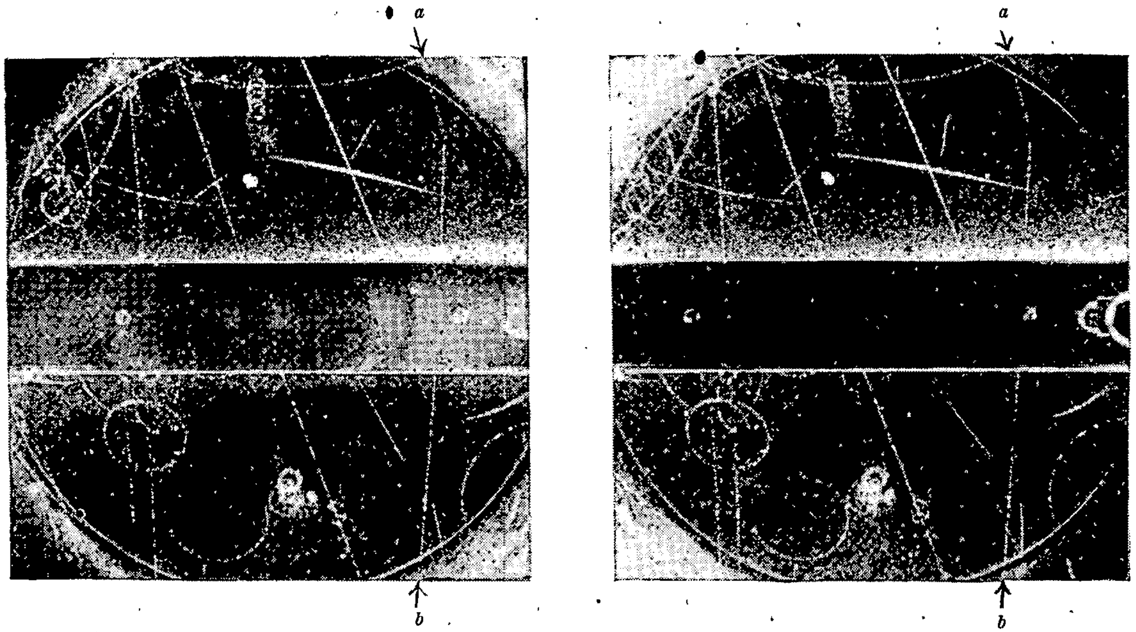

Fig. 2. STEREOSCOPIC PHOTOGRAPHS SHOWING AN UNUSUAL FORK (a b). THE DIRECTION OF THE MAGNETIC FIELD IS SUCH THAT A POSITIVE PARTICLE COMING DOWNWARDS IS DEVIATED IN A CLOCKWISE DIRECTION

The Masses of the Incident Particles

Let us assume that a particle of mass M and initial momentum P is transformed spontaneously into two particles of masses m_1 and m_2, momenta p_1 and p_2 at angles of θ and φ with the direction of the incident particle. Then the following relations must hold :

$$\sqrt{M^2c^4+P^2c^2} = \sqrt{m_1^2c^4+p_1^2c^2} + \sqrt{m_2^2c^4+p_2^2c^2} \quad (1)$$

$$P = p_1 \cos\theta + p_2 \cos\varphi \quad (2)$$

$$p_1 \sin\theta = p_2 \sin\varphi. \quad (3)$$

These general relations may be used to obtain the mass of the incident particle as a function of the assumed masses of the secondary particles.

The value of M must be greater than that obtained by taking the rest masses of the secondary particles as small compared with their momenta ; thus the minimum value $M_{\min}$ is given by the following equation :

$$M_{\min}c^2 = c\sqrt{(p_1+p_2)^2 - P^2}. \quad (4)$$

Applying this equation to the forked track of Fig. 1, after calculating P from the observed values of p_1 and p_2, it is found that $M_{\min}$ is $(770 \pm 200)m$, where m is the mass of the electron. The application of equation (4) to the forked track of Fig. 2, however, after calculating p_2 from the observed values of P and p_1, shows that $M_{\min} = (1{,}700 \pm 150)m$. This value of the mass would require an ionization for the incident particle of twice minimum, which is inconsistent with the observed ionization. We are therefore justified in assuming that the real value of P is greater than the observed value which, as indicated in Table 1, has a large error. If larger values of P are assumed, then $M_{\min}$ is reduced in value. The lowest value of $M_{\min}$ is $(980 \pm 150)m$ if P is $14{\cdot}5 \times 10^8$ eV./c. Beyond this value of P the mass increases slowly with increasing momentum. No choice of incident momentum will bring the mass of the incident particle below 980 m.

In the special case where the incident particle disintegrates transversely into two particles of equal mass m_0, giving a symmetrical fork, equation (1) reduces to the following expression,

$$\frac{M}{m} = \frac{2m_0}{m}\left(1 + \frac{p^2c^2}{m_0^2c^4} \cdot \sin^2\theta\right)^{1/2}, \quad (5)$$

where p is the momentum of each of the secondary particles. Some typical results for different assumed secondary particles, calculated from equation (5), are given in Table 2. On the reasonable assumption that the secondary particles are light or heavy mesons, that is, with masses of $200m$ or $400m$, we find that the incident particle in each photograph has a mass of the order of $1{,}000m$.

TABLE 2. MASS OF INCIDENT PARTICLE AS A FUNCTION OF MASS OF SECONDARY PARTICLE

Photograph	Assumed secondary particle m_0/m	Momentum of observed secondary particle (eV./c.)	Incident particle M/m
1	0	$3{\cdot}5 \times 10^8 \pm 1{\cdot}0 \times 10^8$	770 ± 200
	200	"	870 ± 200
	400	"	1110 ± 150
	1837	"	3750 ± 50
2	0	$7{\cdot}7 \times 10^8 \pm 1{\cdot}0 \times 10^8$	980 ± 150
	200	"	1080 ± 100
	400	"	1280 ± 100
	1837	"	3820 ± 50

Upper values of the masses of the incident particles may also be obtained from the values of the ionization and the momenta. Thus for each of the observed particles in Fig. 1, the ionization is indistinguishable from that of a very fast particle. We conclude, therefore, that $\beta = v/c \gg 0{\cdot}7$. Since the momentum of the incident particle may be found from the observed momenta of the secondary particles, we can apply equation (1) to calculate M. In this way we find $M/m \ll 1{,}600$. Again, since the ionization of the incident particle in Fig. 2 is light, $\beta \gg 0{\cdot}7$, from which it can be shown that $M/m \ll 1200$. This last result, however, must be taken with caution because of the uncertainty in the measured value of the momentum of the incident particle.

One further general comment may be made. This is that the observation of two spontaneous disintegrations in such a small number of penetrating showers suggests that the life-time of the unstable particles is much less than the life-time of the ordinary meson. An approximate value of this life-time may be derived as follows. The probability of an unstable particle of life-time τ_0 decaying in a short distance D is given by

$$p = \frac{D(1 - \beta^2)^{1/2}}{\tau_0\, c\, \beta}. \qquad (6)$$

Since the total number of penetrating particles in the penetrating showers so far observed is certainly less than 50, we must assume that the number of our new unstable particles is unlikely to have been greater than 50. Since one particle of each type has been observed to decay, we can therefore put $p \approx 0{\cdot}02$. Setting $D \approx 30$ cm., and $\beta = 0{\cdot}7$, we find from equation (6) that $\tau_0 = 5{\cdot}0 \times 10^{-8}$ sec.

We shall now discuss possible alternative explanations of the two forks.

Photograph 1. We must examine the alternative possibility of Photograph 1 representing the spontaneous disintegration of a charged particle, coming up from below the chamber, into a charged and an uncharged particle. If we apply the argument which led to equation (4) to this process, it is readily seen that the incident particle would have a minimum mass of 1,280m. Thus the photograph cannot be explained by the decay of a back-scattered ordinary meson. Bearing in mind the general direction of the other particles in the shower, it is thought that assumption of the disintegration of a neutral particle moving downwards into a pair of particles of about equal mass is more probable. Further, it can be stated with some confidence that the observed ionizing particles are unlikely to be protons because the ionization of a proton of momentum $3{\cdot}5 \times 10^8$ eV./c. would be more than four times the observed ionization.

Photograph 2. In this case we must examine the possibility of the photograph representing the spontaneous decay of a neutral particle coming from the right-hand side of the chamber into two charged particles. The result of applying equation (4) to this process is to show that the minimum mass of the neutral particle would be about 3,000m. In view of the fact that the direction of the neutral particle would have to be very different from the direction of the main part of the shower, it is thought that the original assumption of the decay of a charged particle into a charged penetrating particle and an assumed neutral particle is the more probable.

We conclude from all the evidence that Photograph 1 represents the decay of a neutral particle, the mass of which is unlikely to be less than 770m or greater than 1,600m, into the two observed charged particles. Similarly, Photograph 2 represents the disintegration of a charged particle of mass greater than 980m and less than that of a proton into an observed penetrating particle and a neutral particle. It may be noted that no neutral particle of mass 1,000m has yet been observed; a charged particle of mass 990m ± 12 per cent has, however, been observed by Leprince-Ringuet and L'héritier[2].

Peculiar cloud-chamber photographs taken by Jánossy, Rochester and Broadbent[3] and by Daudin[4] may be other examples of Photograph 2.

It is a pleasure to record our thanks to Prof. P. M. S. Blackett for the keen interest he has taken in this investigation and for the benefit of numerous stimulating discussions. We also wish to acknowledge the help given us by Prof. L. Rosenfeld, Mr. J. Hamilton and Mr. H. Y. Tzu of the Department of Theoretical Physics, University of Manchester. We are indebted to Mr. S. K. Runcorn for his assistance in running the cloud chamber in the early stages of the work.

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[3] Jánossy, L., Rochester, G. D., and Broadbent, D., *Nature*, **155**, 142 (1945). (Fig. 2. Track at lower left-hand side of the photograph.)

[4] Daudin, J., *Annales de Physique*, 11e Série, **19** (Avril–Juin), 1944 (Planche IV, Cliché 16).

THE GRASSHOPPER PROBLEM IN NORTH AMERICA

By Dr. B. P. UVAROV, C.M.G.

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OFFICIAL figures compiled by the Division of Grasshopper Control of the United States Bureau of Entomology show that in the ten-year period 1936–46, crops to the value of 424,563,614 dollars were destroyed by grasshoppers, and 26,088,211 dollars was spent on control measures. No similar statistics are available for Canada, where the general situation with regard to grasshoppers is similar. The annual figures for the same period show considerable fluctuation, apparently dependent on natural variations in grasshopper populations; but they do not suggest any general downward trend which might be interpreted as a cumulative result of persistent artificial control measures. It must be stressed that these measures are unquestionably very successful so far as the protection of standing crops of the year is concerned, and the organisation of control, based on close co-operation of Federal and State agencies and the farmers, leaves little to be desired. Both the organisation and the technique of artificial control are being continually perfected, and it is estimated that, on the average, each dollar spent on grasshopper control serves to save crops to the value of 35 dollars. This is a remarkable achievement, and a large share of credit for it belongs to the Division of Grasshopper Control, admirably organised and run by Dr. Claude Wakeland and his staff. Nevertheless, it is clear that the protection of crops by direct control methods cannot be relaxed, and efforts on an ever-increasing scale will have to continue indefinitely. The policy of direct control is a palliative which cannot lead towards a lasting solution of the grasshopper problem in the North American continent.

This state of affairs has been realized by entomologists of the United States and Canada for some time, and their views were forcibly expressed in the following resolution adopted at a session of the Committee on Grasshopper Research at Lincoln, Nebraska, in 1946: "Millions of dollars have been appropriated and spent during the past twenty years by state, provincial, federal and dominion agencies for materials and labour for the applied control of grasshoppers. During the same period, the amount of money spent on research for a solution of the grasshopper problem has been woefully inadequate.

We are convinced that each million dollars spent on grasshopper research now will save hundreds of millions to the people of the United States and Canada in future emergencies." The Lincoln Conference elaborated a programme of research and recommended that such research should be co-ordinated for the whole continent by a permanent Committee on Grasshopper Research of the American Association of Economic Entomologists, through a 'research co-ordinator' whose duty it would be to stimulate research, to assist it and to ensure the co-operation between different research agencies. The important practical question of establishing and financing the 'co-ordinatorship' remained, however, unsolved.

The next session of the Committee on Grasshopper Research was held at St. Paul, Minnesota, in March 1947, and I had the privilege of taking part in the discussions. Afterwards, I was able to visit several of the most important centres of grasshopper research in the United States and Canada and to study their work on the spot. The impressions gained during this short visit may have been incorrect, and are certainly incomplete; but they are of considerable general interest as an illustration of a research policy diverted from its ultimate objective by temporary influences.

All programmes of grasshopper research both in the United States and in Canada are dominated by the need to produce immediate practical results, on which year-to-year financing of research depends. Therefore, two items of research are in the foreground. One is the testing of new insecticides, which are continually appearing on the market. Little fundamental research on insecticide action is in evidence, but purely empirical evaluation of effectiveness and cost take a vast amount of time and energy of research workers. It was somewhat disconcerting to see almost the whole entomological staff of the Federal Grasshopper Research Section occupied for weeks in carrying out field-tests of new insecticides, without any technical assistants or labour. The explanation was the very high cost of labour; but the use of qualified research workers for actual field operations appeared a very questionable measure of economy.

The second problem absorbing research workers is grasshopper survey. Systematic surveys of grasshopper populations were introduced more than ten years ago, and since then three annual surveys (nymphal, adult and eggs) are carried out regularly over all States subject to infestation. Survey methods, sampling technique and the analysis of the data are very elaborate and are standardized throughout, so that, theoretically, one would expect the surveys to produce a vast accumulation of data of great value for an analysis of population trends and the factors regulating populations. Unfortunately, the surveys are primarily intended to provide a statistical basis for the assessment of the expected infestation and for the calculation of quantities of control materials. The value of the survey data for population studies is undoubtedly very great; but the execution of surveys and purely statistical computation of their results appear to occupy practically the whole time of the survey personnel. It was instructive to see how an admirably conceived and perfectly organised machinery for collecting scientific data of great value has enslaved its creators and has made it almost impossible for them to do anything beyond routine work. The amount of the accumulated data is now so great that it would take a team of research workers several years to analyse this material. There is no doubt that such an analysis would provide information on the sources of grasshopper outbreaks and on the factors controlling them; this information would form a basis for formulating a long-range policy directed towards a lasting prevention of grasshopper outbreaks, instead of annual campaigns achieving only temporary relief; but it is apparently very difficult to make the administration realize the need for any expenditure that does not promise immediate return.

The soundness of the idea of grasshopper prevention was freely admitted by American and Canadian colleagues, but they were clearly of the opinion that, under present conditions, it would be futile to contemplate such a policy, which requires planning and execution on a continental scale. This close dependence of an entomological problem on the social structure of the country is most strikingly illustrated by the example of the grasshopper situation in the Phœnix valley of Arizona. It is a wide irrigated plain where cotton cultivation prevailed in the past; but during the Second World War a rise in the price of alfalfa seed caused a great extension of the latter crop. Irrigated alfalfa fields in a semi-desert climate of Arizona provided ideal conditions for *Melanoplus mexicanus* and enabled it to produce up to three generations in a year instead of the normal one. A most serious infestation by this species has developed, and repeated applications of control methods are required to save the crop. Even a cursory examination of the area has suggested that some less well-cultivated fields, with patches of grass, may be the sources of infestation, and a general application of certain cultivation methods may have a far-reaching effect. The possibility of this approach was admitted, but it was pointed out that it will never be possible to induce all growers of alfalfa to adopt improved methods, particularly because in that area the cultivation of alfalfa on such a large scale is due mainly to the high and possibly only temporary profits. Should the price fall, alfalfa will be abandoned in favour of another crop. Under such conditions, any long-range policy is useless to contemplate, and palliatives must continue to be employed. Sooner or later, they may become too costly in relation to the crop value, and the problem of long-range prevention will inevitably arise. It might be a sound policy at least to commence research in that direction before the crisis becomes acute; but it does not appear possible to expect that the necessary funds would be obtainable for a long-range research which does not promise an immediate profit.

Apart from the enforced wrong emphasis in the research programmes, they suffer from a lack of co-ordination. A striking fact is that although certain grasshoppers, notably *Melanoplus differentialis*, are very extensively used in universities as laboratory animals, such research as is carried out in universities is entirely disconnected from field-work executed by the federal grasshopper research agencies, by experimental stations and by the agencies engaged in grasshopper surveys. At the meetings of the Committee on Grasshopper Research, university research workers were conspicuous by their absence, with very few exceptions. As a result, field investigators are often very backward in their approach to the problem, while university workers do not know of the existence of a large number of problems of grasshopper biology which arise in the field but can only be solved in the laboratory.

The need for co-ordinating all grasshopper research has been repeatedly stressed by the Committee on Grasshopper Research, but the impression was that this is an aspiration rather than a demand for a practical measure. It would be natural to suggest that co-ordination of grasshopper research might be organised, or at least financed, jointly by the Governments of the two North American countries, but somehow this appeared to be impracticable.

In spite of all handicaps, American entomologists are making great strides in the study of the grasshopper problem. Unfortunately, their achievements are insufficiently known, since surprisingly little has been published on the subject, mainly because the routine work leaves no time for analysing and summarizing the results. It was even more surprising to hear that many important papers have been ready and waiting for publication for some years. Lack of funds as an explanation did not sound very convincing for a European visiting the United States. The Committee on Grasshopper Research has passed a very strong recommendation that the analysis of accumulated data and the publication of results should be speeded up; but it remains to be seen what the official reaction will be.

It is impossible here to discuss details which would be of interest only to specialists, who have a great deal to learn from the experience of American colleagues, particularly with regard to the technique and the organisation of grasshopper control. A much wider interest is attached to the general aspects of the North American grasshopper problem and its treatment. There is no doubt whatever that the problem is a man-made one, and it reached its great economic importance as a result of land development which was rapid, extensive and unscientific. A rapid expansion of unplanned agriculture in the North American continent has created exceptionally favourable conditions for various insect pests and for grasshoppers in particular. An analogous situation is rapidly developing in Australia, and it is only a matter of time before Africa will be faced with similar results of extensive agricultural development. There is in Africa a vast and varied grasshopper fauna, many members of which will undoubtedly develop into dangerous pests as soon as suitable soil conditions and abundant food are provided for them by the clearing of forests and by mechanized agriculture. At present, African development is threatened by locust plagues, which are a serious factor, but a periodical one; grasshopper plagues, although less spectacular than locust invasions, will be much more serious in their aggregate effects because they tend to be perennial, as the example of North America shows. Anti-locust policy in Africa is developing on the lines of prevention, and it became possible to formulate such policy only after some twenty years of international research. It will take a long time to study the possible effects of mechanized agriculture on native grasshoppers, and it is therefore not too early to consider commencing such studies. The alternative is to do nothing until the danger becomes imminent, by which time it may be too late for any measures of prevention, and perennial artificial control will be required. Again, the American example shows that such control is very expensive and only highly remunerative crops can stand the cost. Agricultural development of Africa is now being planned on a vast scale, and it may be wise not to forget possible handicaps.

ATMOSPHERIC TURBULENCE

MANY workers in atmospheric turbulence probably believe the subject to be more readily capable of formal and exact development than some other branches of dynamical meteorology, a belief deriving from a certain measure of success already attained. But that this success is rather slight is evident when one considers that there is still only slight understanding of turbulence in isothermal flow such as occurs in wind tunnels, pipes, etc., while the atmospheric problems are complicated by the existence of buoyancy forces, positive or negative, by the earth's rotation, and, over the oceans, by the form, of the surface being dependent on the air motion itself. Again, there is a very considerable difference in scale between laboratory and atmospheric flow; but this difference may well be ultimately profitable to an improved understanding of turbulence on all scales—solar, terrestrial (atmospheric and oceanic), and laboratory.

G. I. Taylor effectively established the subject of atmospheric turbulence in his classical paper of 1915. From observations of temperature on the Eiffel Tower and by kite over the Newfoundland Grand Banks, and from Dobson's observations of wind speed and direction in the first kilometre or so over Salisbury Plain, Taylor deduced that the turbulence of the lower atmosphere resulted in an effective coefficient of diffusion of heat or of momentum some 10^4–10^6 times greater than the value for molecular diffusion, the ratio increasing with the wind speed and the lapse-rate of temperature. The equations of heat or momentum transport by which these results were obtained were solved by assuming the turbulent diffusivity constant through the layer concerned, whereas on any simplified picture of eddy motion a variation with height appeared probable; and this variation was involved in the next major advance in the subject early in the last decade. The advance was derived from Prandtl's application of mixing-length ideas growing out of earlier work by Taylor and Schmidt, the mixing-length being an analogue in eddy motion of the mean free path of molecular theory and connoting the mean length of path over which turbulent elements move between birth and extinction, that is, between acquiring and losing a velocity different from that of the mean motion at the levels in question. Prandtl assumed that near a boundary the mixing-length increased linearly with distance from the boundary, and by assuming further that the turbulent elements conserved their momentum during motion (that is, pressure field of no immediate consequence) he deduced that the mean velocity should increase with the logarithm of the distance from the boundary in the region of negligible variation of turbulent shearing stress. This result was in accord with observations in the laboratory for a very wide range of Reynolds number, and in the first 10 m. or so of the atmosphere when in near-neutral static equilibrium. The mixing-length distance relation, more or less confirmed by this agreement of theory with observation, implied that turbulent diffusivity increased linearly with distance from the boundary and was given directly, for momentum transfer at least, from observations of the velocity profile.

Early in the 1920's, L. F. Richardson had examined the effect of static stability on the rate of growth or decay of turbulence. He showed that the rate of production of turbulent energy due to a velocity gradient would compensate the rate of decay due to the work done by eddies against (negative) buoyancy forces, provided the ratio of the square of the vertical gradient of mean velocity to the difference between the adiabatic and actual lapse-rates of mean temperature exceeded a certain critical magnitude. This criterion is only now receiving the attention and application which it merits.

It is to be noted that the above achievements are expressed in the main in terms of the bulk properties of the medium (mean speed and gradients of mean speed and of temperature, etc.), a desirable feature for a ready assessment of the diffusive properties of a given field of mean flow, but inadequate for an understanding of the mechanics of turbulence. Progress in the latter has been rather slight, though much experimental work has been done in the wind tunnel on the measurement of turbulent energy and of its spectrum, and on the correlation between various turbulent velocity components. This has been allied with a promising theoretical treatment of the statistical mechanics of isotropic turbulence, initiated by Taylor in 1935. A little knowledge has been gained of the statistics of atmospheric turbulence in the lower atmosphere, notably by Giblett, Scrase and Best in Great Britain, but there is very little information for the free atmosphere.

This was the background against which the Geophysical Discussion at the Royal Astronomical Society on "Atmospheric Turbulence" was held on October 24. Prof. O. G. Sutton opened the discussion by stressing the alternative approaches to the subject, the approach through the study of bulk properties on one hand and through the study of the internal structure of the fluid on the other, recapitulating the history of the subject and some of the more readily observed characteristics of atmospheric turbulence in illustration. A potentially profitable approach on the structural side was made by Taylor in 1922 in providing a relation between the diffusion of an entity and the correlation between the eddy velocities of a given element of fluid at increasing intervals of time. Sutton developed this treatment by an empirical formulation of the correlation coefficient (direct observations of the correlation coefficient would be very difficult and an *a priori* derivation presupposes a basic understanding of turbulence), and he deduced the rate of transfer of matter (evaporation) from a plane boundary in a turbulent flow, obtaining good agreement with observations for both matter and heat transfer in the laboratory for aerodynamically smooth flow, that is, flow in which the molecular viscosity is responsible for momentum transfer at the boundary itself. This treatment remains to be generalized for aerodynamically rough flow, that is, flow in which the geometrical roughness of the boundary is a controlling factor, and for an atmosphere statically stable or unstable. Sutton also pointed out some of the major meteorological problems of a larger scale requiring investigation and solution, such as the temperature and humidity distribution in the layer which is responsible for the propagation of short radio waves over the earth's surface (see *Nature*, **157**, 860; 1946), and the structure and distribution throughout the troposphere of gusts which on occasion may be a serious hazard for aircraft.

Prof. P. A. Sheppard spoke of his simultaneous measurements of surface drag and the accompanying velocity profile in the air. In the laboratory the mean velocity u at distance z from a boundary is related with the drag τ_0 at the boundary by

$$u = \frac{(\tau_0/\rho)^{1/2}}{k}\left[\log_e\left\{\frac{(\tau_0/\rho)^{1/2}z}{\nu}\right\} + 1{\cdot}75\right]$$

. . . aerodynamically smooth flow,

or

$$u = \frac{(\tau_0/\rho)^{1/2}}{k}\log_e\left(\frac{z}{z_0}\right)$$

. . . aerodynamically rough flow,

where k (about 0·40) is the constant of proportionality between mixing length and distance referred to above, ρ is the fluid density, ν the kinematic viscosity and z_0 a length characterizing the roughness of the boundary. For either type of flow the turbulent diffusivity $K\left(=\frac{\tau_0/\rho}{du/dz}\right)$ is given by

$$K = (\tau_0/\rho)^{1/2}kz,$$

where τ_0/ρ may be obtained from observations of the velocity at two heights. Sheppard's observations were made to determine whether the same relation between profile and drag held in the lower atmosphere, or, alternatively stated, to determine the value of k there. The result, for a moderately unstable atmosphere, was $k = 0{\cdot}45$, in very reasonable agreement with the laboratory value in view of the instability which would enhance k. There was also found to be a significant departure from linearity between mixing-length and height in the sense of larger mixing-lengths at the upper levels of observation—again reasonable in view of the instability arising from buoyancy. Correspondingly, one might expect a departure from linearity in the opposite sense in stable conditions. Such departures must be reflected in corresponding departures from the logarithmic profile of wind velocity. Further, if the mixing-length is the same for any entity diffusing vertically, the profile of that entity should show a variation with stability (Richardson's Number is likely to be the relevant parameter) similar to that for wind velocity. Evidence of such variation was shown in the profiles of wind speed, temperature and vapour pressure obtained by various workers in the first 15 m. or so of the atmosphere; entities increased or decreased less rapidly than the logarithm of the height in unstable conditions, and more rapidly than this in stable conditions. Such profiles imply that the turbulent diffusivity increases more rapidly than the height in unstable conditions and less rapidly than the height in stable conditions. Up to what level these relations apply is not yet known—the increases cannot continue indefinitely.

Mr. F. Pasquill spoke on turbulence in agricultural meteorology and dealt first with the loss of water from soil and crops by turbulent diffusion. If the diffusivity for matter is the same as for momentum, the former is immediately deducible from a velocity profile; and the rate of evaporation E in a steady state (vertical flux of water vapour independent of height) is then obtainable from the vertical gradient of specific humidity $q(E = K/\rho . dq/dz)$. Pasquill's results from observations of the velocity and humidity profiles in the first 2 m. over grass gave quite encouraging agreement with the loss of water determined by soil sampling before and after the profiles had been determined, though the results of the soil sampling were a little ambiguous. Another agricultural application related to the dispersal of wind-borne spores, a problem first tackled by Schmidt many years ago. The spores are dispersed by turbulence as they travel down-wind and are simultaneously deposited on the ground due to fall under gravity—a procedure analogous to the transport of silt in a river or estuary. Pasquill has calculated the rate of deposition at various distances down-wind of the source under given conditions, and obtains quite reasonable agreement with the rather meagre experimental data available.

Mr. K. L. Calder presented some very striking evidence of the applicability of Prandtl's expression for the eddy diffusivity in an isothermal boundary layer to the problem of the diffusion of gas and smoke emitted into the atmosphere near the ground along a line normal to the wind direction. The treatment takes account of the roughness of the underlying surface and gives excellent agreement with a large number of observed concentrations of gas and smoke.

Mr. E. L. Deacon showed a slide of velocity gradients, taken between 2 m. and 4 m. at a given site in various wind speeds and static stabilities, plotted against the Richardson Number for the same height-interval and times of observations. The high correlation shown gave strong support to the growing realization of the importance of Richardson's parameter in atmospheric turbulence.

The 'structural' approach to the study of atmospheric turbulence, either in terms of Prandtl's mixing-length or of Sutton's application of the Taylor correlation coefficient, has been essentially empirical. The mixing-length as used by Prandtl is indeed an idealized concept corresponding to no measurable property of the turbulence itself; it is rather a parameter with the dimension of length which appears from a suitable transformation of the turbulent flux equation. Sutton ascribed the difficulty of developing an *a priori* treatment of turbulence to the non-linear form of the Navier–Stokes equations and saw little hope of overcoming this difficulty, but Mr. G. K. Batchelor ended the discussion on a more hopeful note. He instanced the appreciable success of the fundamental theory launched by Taylor in 1935 to deal with the correlations between eddy velocities at points across and along the direction of mean flow when the turbulence is isotropic, and with the decay of such turbulence in a free stream. The theory is still in vigorous development, and may be expected, sooner or later, to provide better understanding of atmospheric problems.

P. A. SHEPPARD

NEWS and VIEWS

Students in British Universities

IN NATURE of December 6, in the course of an article on "University Expansion in Great Britain", a statement is attributed to Lord Simon to the effect that the output of arts graduates has risen more rapidly than that of science graduates, due to relatively greater ease of expansion on the arts side. Against this remark should be set the figures for university 'populations' given in a written answer by Sir Stafford Cripps in the House of Commons (*Hansard*, House of Commons, December 1). The total number of full-time students at university institutions in Great Britain for the autumn term 1947 was 76,764, compared with 50,246 for the academic year 1938–39. Analysing these totals by faculties, the figures for arts students were 34,200 and 22,512 respectively. The figures under pure science are 14,520 for 1947 and 7,767 for 1938–39; and an approximate doubling is also shown under technology (10,143 and 5,288) and under agriculture (2,337 and 1,043). Thus, whatever may be the present position with regard to the employment of arts graduates, the actual numbers of students in the arts faculties and in the science and technological faculties now in British universities have increased by about the same numbers since 1938–39, namely, 11,688 and 12,902 respectively; but whereas this represents an increase in the arts faculties of 52 per cent, in the science and technology faculties the increase is 91·5 per cent.

Some interesting figures are also given regarding the numbers of students now at the various universities of Britain as compared with the figures for the year 1938–39. Taking the larger universities only, they are as follow, the number in parenthesis being that for the last pre-war year: Birmingham, 2,975 (1,433); Bristol, 1,902 (1,005); Cambridge, 6,943 (5,931); Durham, 3,773 (1,709); Leeds, 2,888 (1,757); Liverpool, 2,943 (2,055); London, 15,789 (13,191); Manchester, 4,632 (2,462); Nottingham, 1,679 (582); Oxford, 7,500 (5,023); Reading, 990 (584); Sheffield, 1,670 (767); Wales, 4,654 (2,779); Aberdeen, 2,007 (1,211); Edinburgh, 4,904 (3,205); Glasgow, 7,073 (4,690); St. Andrews, 1,811 (928). The increases have thus been well spread over the whole country, though the biggest percentage increases are shown by some of the smaller institutions.

Annals of Botany: Prof. V. H. Blackman

READERS of the *Annals of Botany* will have seen with an element of regret that since September 30 Prof. V. H. Blackman has ceased to be editor. Prof. W. H. Pearsall, who succeeds him, is pre-eminently well qualified to do so, and as former editor of the *Journal of Ecology* is well known to many botanical authors. It is, however, fitting to record the very great debt which the botanical world owes to Prof. Blackman who, for more than twenty-five years, has borne with equanimity, kindliness and wisdom the editorship of one of the most influential botanical journals in the world. Almost every working botanist in Great Britain, and many from overseas, have at some time in their lives come under his influence, and the blue pencil has always been administered so graciously that a permanent friendship with the author has generally resulted in spite of compulsory improvement to literary style. It is greatly to be hoped that Prof. Blackman's influence on botany as a whole, and on younger botanists in particular, will continue to be felt for many years in other ways after the very considerable burden of the editorship has been lifted from him.

Sir Evelyn Shaw, K.C.V.O., and the Exhibition of 1851 Scholars

AN interesting informal gathering took place at the offices of the Royal Commission for the Exhibition of 1851 on December 5. A number of former '1851' scholars made a presentation to Sir Evelyn Shaw, who has recently retired from the post of secretary after forty-three years' service with the Royal Commission. Since the awards were inaugurated in 1891, there have been more than five hundred scholars from Great Britain and all parts of the Empire. Most of them have studied in Great Britain and have been grateful for the friendly help given to them by Sir Evelyn Shaw. The presentation consisted of an album containing the signed photographs of 330 'old scholars' from all parts of the world, and a gold coin, dated 40 B.C. and bearing the portraits of Marc Antony and the young Octavius, chosen by Sir Evelyn for his collection. Sir Robert Robinson, chairman of the Science Scholarships Committee of the Royal Commission, and himself a former '1851' scholar, was unavoidably prevented from being present, and sent a goodwill message. The presentation was made on behalf of his fellow scholars by Prof. E. N. da C. Andrade, who expressed the esteem and affection felt for Sir Evelyn by all who had come into contact with him.

Trees and Shrubs as Animal Fodder

THE extent to which animals are dependent on shrubs and trees for fodder is probably not fully realized by those accustomed to associate grazing with true grass or grass–legume pastures, ranges or steppes. The information, however, provided in Joint Publication No. 10, "The Use and Misuse of Shrubs and Trees as Fodder", published by three of the Imperial Agricultural Bureaux (Pastures and Field Crops, Forestry, and Animal Nutrition, respectively) leaves no doubt as to the magnitude of the subject. Over large areas, particularly those with semi-arid climates, in Australia, Africa, India, the U.S.S.R., United States of America and lands in the Mediterranean region, woody plants provide the chief source of food for the numerous low-grade animals kept for the wool, hides and even meat they produce. Most of these regions suffer from gross over-stocking, with a resultant deterioration in the vegetative cover, which in its turn gives rise to serious soil erosion. The problems are numerous, and their solution by no means similar in different parts of the world; but the breeding of better-class animals and a reduction in their numbers should both check the soil erosion and make it economically advantageous to grow improved types of fodder. The best type of management of shrub-tree associations has yet to be found. Experiences with restricted seasonal grazing, reclamation work by re-seeding, and direct shrub cultivation are described and the problems of forest grazing discussed. Bush encroachment on grazing land offers serious difficulty in some countries, and various control measures are being tried for the eradication of undesirable species. As regards nutritive value, the chemical composition and digestibility of some thousand samples of shrubs and trees are tabulated; it is significant that, compared with grassland, the values fluctuate little with season. so that they are of special value in times of drought when indigenous grasses are at their lowest nutritive level. The publication, which contains seventy illustrations, can be obtained from the Imperial Agricultural Bureaux, Central Sales Branch, Penglais, Aberystwyth, Great Britain (9*s*. net).

Agriculture in Northern Ireland

IN 1943 an Agricultural Enquiry Committee was set up to report on the future of agriculture in Northern Ireland, and interim reports on transport and rural housing appeared in 1943 and 1944. The full report has now been published (H.M. Stationery Office. 3*s*. 6*d*. net) and is divided into five main sections, dealing respectively with agricultural policy and production, marketing and processing, education and research, services ancillary to agriculture, and social conditions and the agricultural community. In view of its geographical position and climate, concentration on the production of livestock and livestock products is recommended as a long-term policy. Closely correlated with this is the need for improvement in the grassland, and to carry this out, the establishment of an experimental farm in County Fermanagh is suggested, and the periodic breaking up of the pastures strongly advocated. As regards marketing, the Committee is of the opinion that the Government should continue its policy of guaranteed prices for all major farm products, such prices being based on those considered necessary to call forth the production required, the Exchequer bearing the cost of any subsidies that may be needed. Considerable reorganisation is proposed in the sphere of education, while as regards research, investigations on the nutritive value of grassland, animal breeding and veterinary problems are of special importance to bring the work into line with the general agricultural policy outlined above. Adequate ancillary services are an essential feature, and attention is directed to the need for a satisfactory system of land tenure, and better electricity and water supplies, drainage and sewage schemes. The concluding section of the report puts forward a proposal for the establishment of a Central Agricultural Council, based on existing organisations, which should act as a corporate body for the promotion of the welfare of the agricultural industry and the improvement of social conditions for the rural population.

The Scottish Plant Breeding Station

THE twenty-sixth annual report of the director of the Scottish Society for Research in Plant Breeding provides much evidence of the value of research for agriculture. The Society is in a healthy state, having received a large number of subscription members during the year. New varieties of oats, barley, swedes, grasses and kales are either in commerce or will shortly be released. Three lines of work at the Station are of particular interest. The investigations upon virus diseases and blight of the potato have reached the stage at which the breeding of immune or resistant varieties may be directed. Dr. Gregor has shown that local races of grasses are often of considerable value as source material for breeding in the same way as the ancient local strains of oats and barley were of advantage in the eighteenth century. The genecological studies originally made upon *Plantago* are therefore bearing fruit in agriculture. The director, Mr. W. Robb, has been selecting suitable strains from among more than 15,000 hybrids of oats with the view of combining stiff straw, and freedom from lodging, with high yields. As the result of negotiations between the Society and other bodies it will be possible to enlarge the grounds and the activities in the near future.

An Electric Heater for Flasks

AN electric 'mantle' for the heating of flasks, termed an 'Isomantle', has recently been introduced into Great Britain by Messrs. Towers and Co., Ltd., of Widnes. It consists essentially of a tough, double-walled, glass-cloth shroud, hemispherical in shape and carrying a nichrome/glass-cloth heating-element in close proximity to the inner wall. A packing of glass-wool provides efficient thermal insulation, and the whole unit is carried in a neat aluminium cradle which may either be placed directly on the bench or supported by a retort stand. Temperature is regulated by a series resistance or, more effectively on an A.C. supply, by a device named the 'Simmerstat', which gives continuous and accurate control of heat from zero to a maximum sufficient to boil liquids at 300–350° C. Laboratory tests show that an 'Isomantle' provides a really safe and efficient method of heating liquids, particularly for operations such as routine solvent extraction. Flask breakage will be reduced to a minimum, and the large heating-area promotes uniform boiling. Deliberate efforts to induce the 'bumping' of boiling liquids were quite unsuccessful. A range of sizes from 100 to 5,000 ml. is being prepared; it is to be hoped that the manufacturers may eventually find it possible to 'tailor' jackets of other shapes for special purposes.

Research in the Jewellery Industry

The first annual report of the Design and Research Centre for the Gold, Silver and Jewellery Industries has been issued (Goldsmiths' Hall, Foster Lane, London, E.C.2); the Centre was inaugurated on October 1, 1946. After referring briefly to the initiation of market and consumer research, the training of designers, including the provision of refresher courses and the plans for development of the library and reading room and information service, the report deals with the plans of the research section. Prof. R. S. Hutton was originally appointed honorary acting director of research, and an Advisory Research Committee has formulated a research programme and initiated investigations on tarnish-resisting silver at the Metallurgical Laboratory, University of Cambridge, and on polishing processes, temper-hardened silver, coloured patina and other metal finishes at the Sir John Cass Institute, London. Dr. C. E. Garden was appointed director of research and took up his duties on June 2, 1947, and an industrial liaison officer has also been appointed. An information bulletin is being issued, and a research laboratory is being established at Goldsmiths' Hall, London.

Californian Academy of Sciences

In the annual report of the Californian Academy of Sciences for the year ending December 31, 1946, the president, refers to the decision of the trustees to proceed with a campaign for raising funds which will make possible the construction of a planetarium adjacent to the Academy's buildings in Golden Gate Park. It is also planned to build an addition to the African Hall, an auditorium and additional housing to relieve the over-crowding of several of the departments. The director, Dr. R. C. Miller, refers in his report to the resumption of field-work by nine members of the Museum staff, who made eleven field trips to points ranging from Newport, Oregon, to Acapulco, Mexico, and from the seashore to the High Sierra. Many accessions to the departmental collections were made during the year, and the director reports briefly on the work of the Academy's Committee of Latent Natural Resources, established in January 1942, to organise research relating to the existing national emergency. The work of the Committee was carried on chiefly by correspondence; the Committee has had a leavening influence far beyond the range of its immediate activities, which included the location of strategic minerals, the resources of the sea for war-time economy, black glass for mirrors for navigating instruments and tuna fisheries. The Committee is being retained as a stand-by committee for consultation on similar problems as need may arise.

University News

A chair of genetics is to be established in the Faculty of Science, University of Birmingham.

Mr. Charles R. Morris, formerly fellow of Balliol College and later Under-Secretary at the Ministry of Production, has been nominated as vice-chancellor of the University of Leeds in succession to Dr. Mouat Jones, who retires on October 1, 1948.

Mr. R. L. Goodstein, lecturer in mathematics in the University of Reading, has been appointed professor of mathematics in University College, Leicester.

Dr. F. E. King, lecturer in chemistry in the University of Oxford, has been appointed Sir Jesse Boot professor of chemistry in University College, Nottingham.

Announcements

We regret to announce the deaths of Earl Baldwin of Bewdley, K.G., P.C., F.R.S., on December 14, aged eighty; Dr. Charles Bolton, C.B.E., F.R.S., consulting physician to University College Hospital, London, on December 6, aged seventy-four; and the Right Hon. Lord Rayleigh, F.R.S., on December 13, aged seventy-two.

Prof. A. E. Muskett, professor of mycology and plant pathology in the Queen's University of Belfast, has been elected president for 1948 of the British Mycological Society.

The Atomic Scientists News, the journal of the Atomic Scientists' Association (limited by guarantee), issued approximately monthly, has hitherto only been available to members of the Association. To enable libraries and institutions, and other individuals who do not wish to join the Association, to obtain copies, a subscription scheme has been started. The subscription is 10*s.* 6*d.* a year, and further particulars are obtainable from the editor, Dr. C. H. Westcott, Physics Department, University, Edgbaston, Birmingham, 15.

The international journal of cytology *Chromosoma* was founded by Dr. Hans Bauer, of the Kaiser-Wilhelm Institut für Biologie in Berlin Dahlem, in 1939. It completed its second volume during the War, the last issue appearing in 1944. Its publication has been resumed by the Springer-Verlag, now in Vienna, with a double number (Volume 3) dated August 1947. This number contains papers by Seiler, Geitler, Le Calvez, Schrader and others on many aspects of chromosome behaviour in plants, animals and protista.

An exhibition, "Highways of the Air", is being arranged by the Royal Geographical Society, in co-operation with the Ministry of Civil Aviation, the British Airline Corporations and the Ministry of Education, at the Society's house in Kensington Gore, London, S.W.7, during December 22–January 15; it will be open from 11 a.m. to 5 p.m. on weekdays (except Christmas Day and Boxing Day) free of charge. The exhibition has been planned against the background of the air-age geography and the development of civil airways.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electron Microscopy of Bacteria

BACTERIA have usually been prepared for observation in the electron microscope by growth in liquid media, a drop of the suspension being allowed to dry on a collodion-covered specimen grid. Smiles[1] has employed an adaptation of the impression technique used in optical microscopy for obtaining material from a surface culture: a glass slide pressed on to the agar removes a film of bacteria, which is allowed to dry partially, and then removed by stripping with a collodion film. Hillier and Baker[2] have described a more direct method, in which the collodion film is formed on the agar surface and then floated off in water. Unfortunately, most bacteria, however mounted, prove to be too opaque to an electron beam of the energy usually employed (50–60 kV.) to show appreciable internal structure.

In studying the morphology of avian tubercle bacilli, which, in certain stages of development, we find to be less dense to electrons than most bacteria, we found it impossible to strip them from the Löwenstein and blood-agar surfaces on which they are normally grown. Two methods have been devised by which intact films can consistently be obtained. In the first, a thin coating of glycerine-agar is spread on the surface of the Löwenstein medium and the bacterial inoculum placed on this. After sufficient growth has developed, a 1 per cent solution of collodion is flowed over the surface, allowed to dry, and removed by immersion in water. Alternatively, a square of the Löwenstein medium, at the required stage of growth, is inverted and the surface pressed firmly for a few seconds on to a glycerine agar surface, so that the culture is transferred from the one to the other. It may afterwards be removed from the latter as before by stripping on a collodion film. In either case the specimen grids are then placed on the stripped film, and both removed and mounted in the usual way. The resulting electron micrographs show a richness and clarity of internal structure not otherwise obtainable (Figs. 1–4). Before spreading the collodion film on the culture, it is fixed by exposure for 5 min. to the vapour of 2 per cent osmic acid. As a further precaution against infection, a 5 per cent solution of formalin is employed for floating off the collodion films, which are then washed in distilled water before mounting. Fixation in formalin vapour proved unsatisfactory in that the films could not afterwards be stripped at all.

An interpretation of the results obtained at different stages in the life of a culture will be published elsewhere.

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[1] Smiles (demonstrated to the third Electron Microscope Conference, National Institute for Medical Research, London, June 1945).

[2] Hillier and Baker, *J. Bact.*, 52, 411 (1946).

A New Isotope of Tungsten

A SEARCH for tungsten radio-isotopes was made using a 5-mil tantalum foil which had received 80 micro-ampere-hours bombardment with approximately 20 MeV. deuterons from the 60-in. Crocker Laboratory cyclotron. The foil was dissolved in nitric acid containing five per cent of hydrofluoric acid. A few milligrams of tungsten carrier was added, and after removal of hydrofluoric acid by fuming with sulphuric acid, the tantalum was precipitated by sodium hydroxide and the precipitate digested with hot alkali. Tungsten was precipitated from the alkaline solution by boiling with excess nitric acid. The procedure was repeated until the tantalum-scavenging carrier precipitates were inactive.

The tungsten fraction contained a previously unreported, single radioactivity of half-life 140 ± 2 days, emitting electrons, X-rays and gamma-rays. The radiations were studied using aluminium, beryllium and lead absorbers, measurements being made with an 'end-on' type Geiger – Müller counter with a 2·7 mgm./cm.^{2} mica window, and filled with 10 cm. argon and 0·5 cm. alcohol. The radiations had the following characteristics.

(1) Electrons of range ∼ 11 mgm./cm.^{2}, corresponding to an energy of about 90 keV. The range was determined by resolution of the aluminium absorption curve (Fig. 1) and by direct measurement using thin beryllium absorbers. The absorption of the soft X-ray background was measured in aluminium after removal of electrons by a 14 mgm./cm.^{2} beryllium absorber.

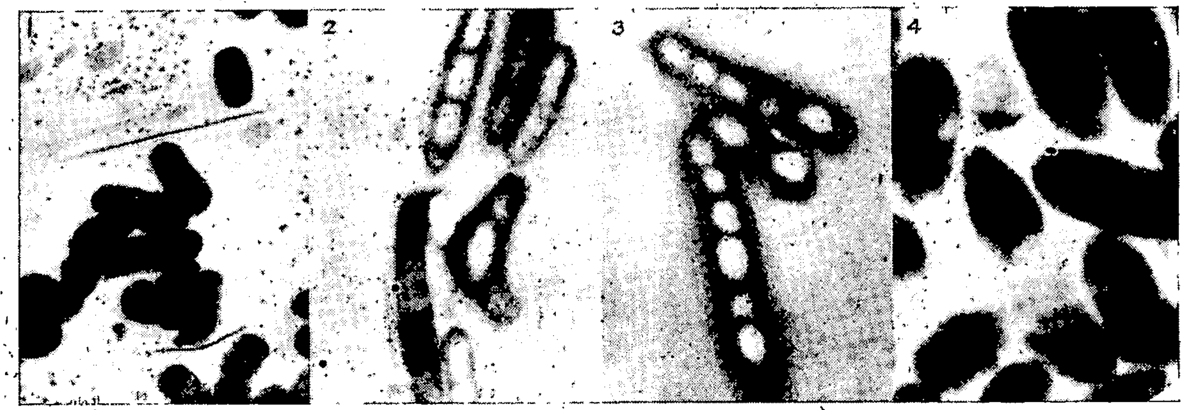

Fig. 1. INOCULUM OF AVIAN TUBERCLE BACILLI, FROM A CULTURE FOUR WEEKS OLD
Figs. 2 and 3. INTERMEDIATE FORMS AFTER 24 HOURS AND THREE DAYS INCUBATION ON LOEWENSTEIN MEDIUM
Fig. 4. FORMATION OF DAUGHTER RODS AFTER FOUR DAYS. × 15,000

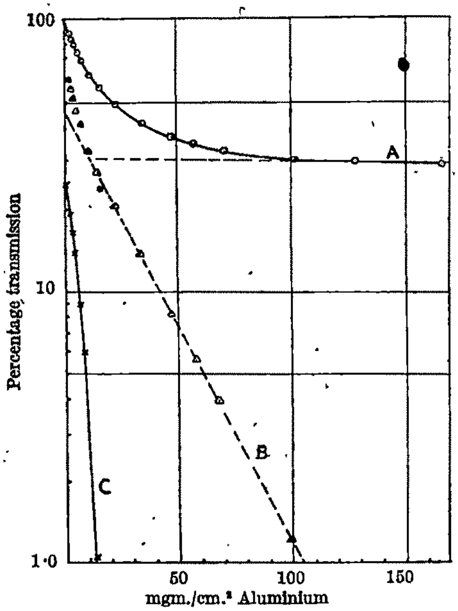

Fig. 1. ALUMINIUM ABSORPTION CURVE
A, *K* X-ray and γ-background ; *B*, *L* X-rays, half-thickness 17 mgm./cm.² ; *C*, electrons range ~ 11 mgm./cm.²

(2) Electromagnetic radiation of half-thickness 17 ± 1 mgm./cm.² aluminium, 124 ± 4 mgm./cm.² lead and 15 ± 0·4 gm./cm.² lead, corresponding respectively to energies of 8·7 keV., 59 keV. and 1·83 MeV. The lead absorption of the two harder components is shown in Fig. 2.

The ratio of electrons to quantum radiation was determined for an 'infinitely thin' sample mounted on a mica slip of mass thickness 0·6 mgm./cm.². Making corrections for counting fluctuations, for absorption in the counter window, air gap, etc., and assuming equal counting efficiencies of 1 per cent for the 59 keV. and 1·83 MeV. rays, with an efficiency of 3·3 per cent for the 8·7 keV. ray, the following ratios were obtained: Electrons : 8·7 keV. ray : 59 keV. ray : 1·83 MeV. ray = $2 \times 10^{-2} : 1{\cdot}0 \pm 0{\cdot}1 : 1{\cdot}0 : 1{\cdot}0 \pm 0{\cdot}2 \times 10^{-2}$.

The sample was further investigated using a crude β-ray spectrometer, measurements being made with fields up to 16,000 gauss/cm. No positrons or electrons of energy greater than 100 keV. were observed, but only a single peak of electrons. The peak value (Fig. 3) corresponds to an electron energy of 70 ± 2 keV.

The allocation of the isotope to mass 181, and the assumption that it is formed by a (*d*,2*n*) reaction in tantalum, seems reasonable. A single tungsten activity only, which has no tantalum daughter of half-life greater than a few minutes, has been found. The (*d*,2*n*) and (*d*,4*n*) reactions in tantalum only could lead to an active tungsten isotope, if the possibility of a long-lived isomer of stable W^{180} or W^{182} is excluded. The yield of the (*d*,4*n*) reaction with the 20 MeV. deuterons used would be too small by a very considerable factor to account for the observed activities. Further, no evidence of any isotope emitting X-rays was found in the separated tantalum fraction, which contained only the well-known 97-day Ta^{182}.

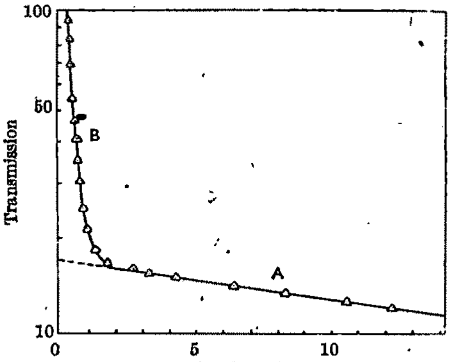

Fig. 2. LEAD ABSORPTION CURVE
A, γ-ray, 15 gm./cm.² half-thickness, measured up to 46 gm./cm.² lead ; *B*, *K* X-rays, half-thickness 124 mgm./cm.²

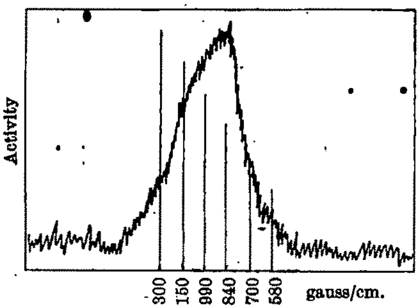

Fig. 3. ELECTRON DISTRIBUTION ON 'MAGNETIC COUNTER'

The measured half-thicknesses for the electromagnetic radiation agree well with the values of 17·8 mgm./cm.² aluminium, and 128 mgm./cm.² lead calculated for the *L* and *K* X-rays of tantalum respectively, using data given by Compton and Allison[1] for the energies and intensity ratios of tantalum X-radiation. The radiations of the new isotope are thus compatible with the assumption of orbital electron capture in tungsten. The small fraction of disintegrations through the 1·83 MeV. gamma-ray and conversion electrons might be accounted for by transitions to metastable states in Ta^{181}. De Benedetti and McGowan[2] have observed a metastable state in Ta^{181} of 22 microsec. half-life produced in the beta decay of Hf^{181}. The radiations[2,3] consist mainly of electrons of ~ 110 keV. energy, and it was suggested that these were due to conversion of a 180 keV. gamma-ray in the *K*-shell. The excitation energy of the metastable level would be ~ 180 keV., with a transition to the ground state involving a probable spin change of 3 units, from ½ to 7/2. The energy of the electrons observed in the decay of the new tungsten isotope agrees reasonably with that reported for the conversion electrons from Ta^{181*}, and corresponds to a 140 keV. gamma-ray completely converted in the *K*-shell. Since no 1·83 MeV. gamma-ray is reported in the disintegration of either Ta^{181*} or Hf^{181}, a further level above that of the 22 microsec. state must be assumed, with electron capture in W^{181} leading directly to each of the two states in approximately 1 per cent of the transitions.

Acknowledgment is due to Dr. T. G. Hamilton and the crew of the 60-in. cyclotron for assistance in bombardments, to Prof. G. T. Seaborg for his advice and criticism, and to the University of California for the use of its facilities.

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Primary Ionization of β-Particles in Alcohol Vapour and Argon

THE efficiency of a counter for detecting ionizing particles can be written

$$\varepsilon = 1 - \exp(-Spl/76), \qquad (1)$$

where S is the primary ionization of the particle in the gas at N.T.P., p the pressure in cm. of the contained gas at 0° C., and l the length of the path of the particle in the counter. T. Graf[1] has made use of this fact to measure the primary ionization of β-particles in air. Two counters were placed in a spectrograph so that all particles passing through the second counter had, of necessity, also passed through the first. If N is the rate of counting in the second counter and N_c the coincidence counting-rate, the efficiency of the first counter is given by

$$\varepsilon = N_c/N. \qquad (2)$$

A knowledge of l and p then enables S to be calculated from equation (1).

We have, by this method, investigated the primary ionization of β-particles in mixtures of argon and ethyl alcohol vapour. For a mixture, formula (1) can be written

$$\varepsilon = 1 - \exp\{-(S_1p_1 + S_2p_2)l/76\}. \qquad (1a)$$

S_1 and S_2 can be evaluated by determining ε for two different combinations of the partial pressures p_1 and p_2.

The experiment was performed for β-particles of one energy only, namely, 0·42 MeV., and the mean values obtained were 79·0 ion pairs/cm. in alcohol vapour and 29·8 ion pairs/cm. in argon. These are consistent with values of 68·7 ion pairs/cm. and 25·9 ion pairs/cm. respectively for β-rays of energy 1 MeV.[2].

The value for argon is in agreement with measurements made with fast cosmic rays[3].

Hazen[4], by plotting a curve of primary ion pairs/cm. against electrons per molecule for five gases and extrapolating, estimates a value of 33 ion pairs/cm. for alcohol vapour. By adding the measured values for C_2, $3H_2$ and $\frac{1}{2}O_2$, he obtains a value of 42 ion pairs/cm. On either basis the value obtained is considerably smaller than the value we have measured. Indeed, on theoretical grounds[5] the measured value of 69 ion pairs/cm. is only consistent with an effective ionization potential of 7–8 electron volts.

It is noteworthy that the efficiency of a counter containing alcohol vapour at 1 cm. mercury pressure measured by Rochester and Jánossy[6] suggests a value of at least 61 ion pairs/cm. for alcohol vapour.

If any single ion pair escapes detection in the argon-alcohol counters, the value of the primary ionization for alcohol vapour would be even greater than 69 ion pairs/cm. This type of counter is, however, likely to be 100 per cent efficient, in contrast with the slow types used in earlier work[1,7,8].

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Relations Between Structure-Factors

IF the edges of the unit cell of a crystal are all taken equal to 1, the electron-density function can be expressed as a three-dimensional Fourier series of the form

$$\rho(x,y,z) = \sum_{h=-\infty}^{\infty} \sum_{k=-\infty}^{\infty} \sum_{l=-\infty}^{\infty} F_{h,k,l} \exp\{2\pi i(hx+ky+lz)\}.$$

It is a commonplace of crystallography that X-ray diffraction methods can tell us the value of $|F_{h,k,l}|$ but never the actual phase of $F_{h,k,l}$. If we restrict ourselves to the case of a centro-symmetric crystal, we can take the F's real and so

$$F_{h,k,l} = \alpha_{h,k,l}\,|F_{h,k,l}|,$$

where the second factor on the right-hand side is known and $\alpha_{h,k,l} = \pm 1$.

Harker and Kasper[1] have recently shown that the $F_{h,k,l}$'s must satisfy certain relations of inequality, and that these relations sometimes enable one to decide unequivocally for some values of (h,k,l) whether $\alpha_{h,k,l}$ is $+1$ or -1. I have succeeded in extending these ideas and have established several large classes of inequalities between $F_{h,k,l}$'s. Applying the inequalities to the data on oxalic acid given by Robertson and Woodward[2], I have been able to determine the signs of some forty-two terms. I believe that more of the signs can be obtained directly, though I have not yet succeeded in doing so. In any event, however, these forty-two terms give a more than adequate first approximation, which can be followed up either by the usual methods or by the use of modern computing machinery.

Apart from the practical application of these ideas to the determination of phases, they also lead to some rather curious restrictions on the structure-factors. I have investigated a number of cases and have verified that these restrictions were, in fact, always satisfied, though no really adequate physical explanation of them suggests itself.

A full account of the whole subject will shortly be published elsewhere.

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[1] In a paper read at the 1947 summer meeting of the American Society for X-Ray and Electron Diffraction at St. Marguerite, Quebec.

[2] *J. Chem. Soc.*, 1817 (1936).

Meson Decay and the Theory of Nuclear Forces

IN recent observations with the photographic plate method, Lattes, Muirhead, Occhialini and Powell[1] have given direct evidence of cosmic ray mesons with two different masses; furthermore, in some of their pictures the heavier meson stops in the emulsion and emits a lighter meson. At first one is tempted to identify these two mesons with the vector and pseudoscalar ones postulated in the Schwinger mixed meson theory of nuclear forces. Wentzel[2] has, in fact, recently suggested that a vector meson can disintegrate into a pseudoscalar meson plus a photon, and one might conjecture whether this is not the process observed by the Bristol group[1]. According to calculations by Finkelstein[3], this process has a lifetime of 4×10^{-18} sec. and would thus be too fast to be detected in the plate. Finkelstein's results show, in addition, that the contribution of the vector meson instability to the soft component of cosmic radiation would result from that process, that is, from photons and not from β-decay, which would then be slower by a factor of 10^{10}.

More recent data[4] indicate, however, that the meson decay of mesons is probably accompanied by the ejection of light neutral mesons instead of photons. If this is true, Schwinger's usual mixed theory cannot account for the meson decay. Apart from the difficulty that Finkelstein's theory gives too short a life-time for this process, one would have to assume in this theory, besides the usual vector and pseudoscalar mesons, lighter mesons with spin 1. The scheme of the process would then be

$$\mu_v^{\pm} \rightarrow \mu_{ps}^{\pm} + \mu'_0, \qquad (1)$$

where μ'_0 is a spin 1 neutretto with a mass of the order $\frac{1}{2}$ of that of $\mu_v^{\pm}$ [4]. The additional assumption of a light vector neutretto field to account for this scheme would destroy the regularity of the non-relativistic potential of two nucleons in Schwinger's theory, unless a corresponding light pseudoscalar neutretto field were also introduced. One possibility which is open is given by a non-symmetrical mixture of two meson fields. Hulthén has already suggested a mixture of a neutral scalar and a charged pseudoscalar field[5]. But one might assume that for a given field the meson mass and the coupling constants depend on the charge. In this case, the potential energy of two nucleons as derived from a vector field would be

$$V = \sum_a \tau_a{}^{\mathrm{I}} \tau_a{}^{\mathrm{II}} \left\{ (g_1{}^a)^2 + \tfrac{2}{3} (g_2{}^a)^2 (\vec{\sigma}_{\mathrm{I}} \cdot \vec{\sigma}_{\mathrm{II}}) - \tfrac{1}{3} (g_2{}^a)^2 S \left(\frac{3}{(\mu_v{}^a r)^2} + \frac{3}{\mu_v{}^a r} + 1 \right) \right\} \frac{\exp\,(-\mu_v{}^a r)}{r};$$

$$S = \text{tensor force};$$

and analogously for the potential as deduced from the pseudoscalar field. One can then have immediately the potential by mixing the two fields.

We have, in particular, examined the non-symmetrical Møller – Rosenfeld mixture[6]. In this case, and assuming that the coupling constants are the same for charged and neutral mesons, the theory will give a neutron-proton interaction in the ^1S state slightly larger than the (specifically nuclear) proton-proton interaction in the same state if the neutral meson mass is slightly larger than the mass of charged mesons. Such a result might be consistent with Hanstein's observations[7]. In Born's approximation, the effect of varying the neutral meson mass on the anisotropy of neutron-proton scattering at 14 MeV. gives no substantial deviation from the prediction of the symmetrical theory. However, one would need a neutral meson lighter than the charged ones for process (1), and this would make the proton-proton potential in the singlet state larger than the neutron-proton potential in the same state, which is at variance with the available experimental evidence. The same conclusions are expected to result in the case of a non-symmetrical Schwinger's mixture.

Another possibility would be to assume light pseudovector mesons in addition to pseudoscalar and vector mesons. But there still remains the difficulty of too short a life-time for the meson decay with emission of photons, if one wishes to identify the heavier meson[1] of the Bristol group with a spin 1 meson. If, therefore, the meson decay of mesons is accompanied by the emission of light neutrettos, a more radical change will be needed in the present meson field theory of nuclear forces.

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Interpretation of Radio Echoes from Polar Auroras

IN a recent communication, Lovell, Clegg and Ellyett[1] describe radio echoes from polar auroras. A remarkable feature was a persistent echo on 6·5 metres wave-length (46 Mc./s.) with an amplitude three times the noise-level and a distance of 480 km. The echo was not observed on 4 metres wave-length; it finally disappeared when striations occurred in the aurora.

The observers have kindly supplied the following data on the radar set used for the observations: peak transmitter power 50 kW. on 6·5 m., 100 kW. on 4 m.; aerial gain of 4 compared with a free dipole for transmitter and receiver on both wave-lengths; noise-level equivalent to $1 \cdot 8 \times 10^{-14}$ watts receiver input on 6·5 m., and to $0 \cdot 4 \times 10^{-14}$ watts on 4 m.

If the echo was due to reflexion from a plane surface, the reflexion coefficient, that is, the ratio between incident and reflected energy, would be of the order 5×10^{-7}. The well-defined range of the echo indicates that reflexion from a plane surface is a plausible assumption, and even if the plane reflector is replaced by an irregular surface, the magnitude of the reflexion coefficient would not be substantially altered, since the aurora covered an appreciable area of the sky.

Radar observations of meteors during this auroral display indicated no increase in the absorption up to 90 km. height, and the electron collision frequency at greater heights is too small to be effective at radio frequencies of 46 Mc./s. or more. The very low reflexion coefficient is therefore not due to absorption, but indicates that the auroras were practically transparent to radio waves of 46 Mc./s. frequency. *The electron density must therefore be considerably smaller than* $2 \cdot 6 \times 10^7$ *electrons per c.c.*

In a transparent layer of uniform electron density, the reflexion coefficient depends on the electron density and on the sharpness of the boundary layers. For a given maximum electron density, the reflexion coefficient is highest when both boundaries are perfectly sharp, and the radiation from both boundaries is received with the same phase. If these conditions are fulfilled, the optimum reflexion coefficient is

$$R = \frac{e^4}{4\pi^2 m^2 \nu^4} N_0{}^2. \qquad (1)$$

Equation (1), which is valid for small R, shows that if $R = 5 \times 10^{-7}$, *the electron density* N_0 *must be greater than* 4×10^4 *electrons per c.c.*

If the boundaries are diffuse, the optimum reflexion coefficient R is reduced by a factor

$$f = \left| \frac{1}{N_0} \int \frac{dN}{dx} \exp\left(i \frac{4\pi}{\lambda} x\right) dx \right|^2. \quad (2)$$

It is assumed in (2) that R is considerably less than unity. λ is the radio wave-length *in vacuo*; the integration is extended over the boundary layer.

If N_0 is near the lower limit, f must be nearly unity; if N_0 is approaching the upper limit, f must be of the order 10^{-6}. From these limiting values of f we can obtain information on the sharpness of the boundary layers. Assume, for analytical simplicity, that

$$\frac{dN}{dx} = \frac{N_0}{a\sqrt{\pi}} \exp\left(-\frac{x^2}{a^2}\right), \quad (3)$$

which would correspond to a sharp boundary which has been subject to a diffusion process. We find in this case

$$f = \exp\left(-\frac{8\pi^2 a^2}{\lambda^2}\right), \quad (4)$$

and using the lowest permissible value of f, we find that $a < 3$ metres.

It is known from aurora photographs[2] that the sides of draperies and rays appear sharp to within less than a few hundred metres; the limit is set by the resolving power of the cameras and films. From the present interpretation of radio echoes, it appears that the boundaries are sharp within some metres. This conclusion depends to some extent on the analytical expression which is chosen to represent the electron distribution in the boundary layers, but different expressions give the same order of magnitude.

Diffusion in the aurora-levels is too fast for the boundaries of an accumulation of electrons to remain so sharp for 20 min. Aurora photographs show that the lower borders of arcs, draperies and rays are much less clean-cut than their vertical sides. For these reasons it is difficult to understand how the radio echo described by Lovell, Clegg and Ellyett could be caused by reflexion from the bright area which was observed near zenith. As an alternative interpretation it may be suggested that the echo was due to reflexion from the vertical surfaces of a stationary discharge (an auroral arc) at a range of 480 km. close to the northern horizon, and that the reflexion occurred from the point where the radius from the radar station was normal to the surface of the arc. Since such arcs follow the lines of magnetic field, this point would be located at about 200 km. height over the north of Scotland; aurora records from this region during the night of August 15–16 would be very desirable. It is worth noting that a height of 200 km. is well above the region of maximum luminosity in ordinary auroral arcs.

As seen from equations (1) and (2), the reflexion coefficient should decrease with decreasing wave-length, and it may be readily understood that the echo was observed on 6·5 metres, but not on 4 metres wave-length. The disappearance of the echo when the aurora split into rays is also to be expected, since a plane arc is a more efficient reflector than a cylindrical ray.

Further observations of this kind during magnetic storms and auroras would be desirable. If the echoes detected by Lovell, Clegg and Ellyett are due to reflexions from a point well above the luminous parts of an auroral arc, there is a possibility that echoes might be observed from the current sheets outside the earth's atmosphere during magnetic storms. For this purpose one might, as a first guide, assume that the auroral discharges take place on the surface generated by the magnetic field lines through the aurora zone, and for each locality the most favourable directions and ranges can be readily evaluated from the condition that the radius from the station should coincide with the normal to this surface.

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Oct. 11.

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Low-Temperature Polymerization of Isobutene by Titanium Chloride

It has been shown in previous communications[1,2] that the low-temperature polymerization of isobutene in hexane solution by titanium chloride ($TiCl_4$) requires a co-catalyst. Water was found to be an effective co-catalyst, but only when introduced into the reaction mixture in the form of vapour, where it presumably forms crystallites of high specific surface which react with the titanium chloride. These considerations, and the milky appearance of the polymer solution at the end of the reaction, indicated that the initiation step at least might be heterogeneous.

Using the apparatus and method previously described[2], it was found that the reaction could also be initiated by the addition of a few drops of commercial concentrated sulphuric acid. 20 per cent oleum had the same effect, so that it is improbable that the active principle in the sulphuric acid was the water contained therein. Neither sulphuric acid nor oleum alone (without titanium chloride) initiate polymerization at −70° to −80° C., although they do so at room temperature. The reaction initiated at about −80° C. by concentrated sulphuric acid or oleum as co-catalyst is of an extreme violence comparable with that of the boron trifluoride catalysed reaction.

Concentrated sulphuric acid, oleum and water were not considered altogether suitable co-catalysts for kinetic studies, and a co-catalyst was sought which would be soluble and which would form a titanium chloride complex also soluble in hexane. The substances acting as co-catalysts in the boron trifluoride catalysed, room-temperature, gas-phase polymerization of isobutene, such as acetic acid[3,4,5], which are soluble in hexane, were found to act as inhibitors to the titanium chloride catalysed, low-temperature, liquid-phase polymerization of isobutene. Further search was made for a hexane-soluble acid of strength comparable to sulphuric acid. It was found that dry trichloracetic acid in hexane solution was an efficient co-catalyst. The titanium chloride – trichloracetic acid complex was found to be soluble in hexane at the concentrations used at temperatures so low as −85° C. Polymer solutions produced by titanium chloride – trichloracetic acid are free from opacity or even opalescence until exposed to the atmosphere. With a ratio of chloride to acid less than about 4, the curves showing the progress of reaction with time are slightly sigmoid, but for higher values of this ratio their slopes decrease monotonically from the start. For starting temperatures near −80° C., the maximum rate of the polymerization under adiabatic conditions is found to be a function of the concentrations of isobutene, titanium chloride and trichloracetic acid, and of the initial temperature. The detailed relationships are being investigated.

Picric acid, the dissociation constant of which is of the same order as that of trichloracetic acid, was found to be inactive as co-catalyst, but did not affect the polymerization afterwards induced in the same reaction mixture by the addition of trichloracetic acid. Monochloracetic and dichloracetic acids were found to possess practically no co-catalytic activity at −75° C., but slowed down considerably the polymerization afterwards induced by the addition of trichloracetic acid.

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Sept. 17.

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[1] Evans, A. G., *et al.*, *Nature*, 157, 102 (1946).

[2] Plesch, Polanyi and Skinner, Discussion on "Some Aspects of the Chemistry of Macromolecules", *J. Chem. Soc.*, 257 (1947).

[3] Evans, A. G., and Polanyi, *J. Chem. Soc.*, 252 (1947).

[4] Evans, A. G., Meadows and Polanyi, *Nature*, 158, 94 (1946).

[5] Evans, Meadows and Polanyi (see following letter).

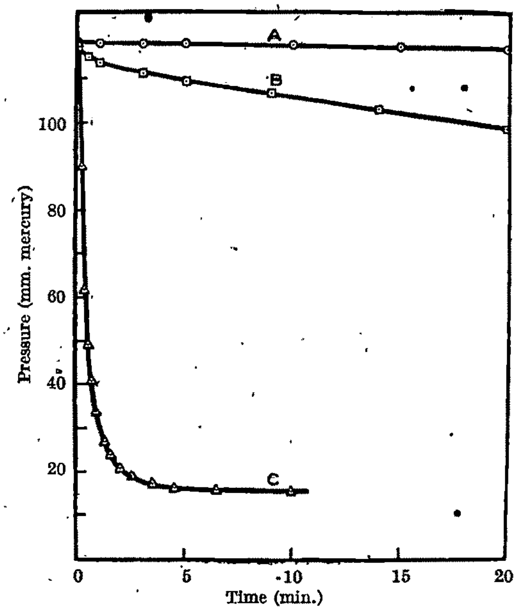
Polymerization of Olefins by Friedel-Crafts Catalysts

Earlier work has shown that pure isobutene gas and pure di-isobutene vapour do not undergo reaction when mixed with gaseous boron trifluoride[1]. In the presence of a trace of some third component, or co-catalyst as we shall call it, these monomers undergo very rapid polymerization when mixed with boron trifluoride. Water[1] and *t*-butyl alcohol[2] act as co-catalysts in this way.

We now find that acetic acid also is an effective co-catalyst in these reactions. Isobutene gas containing as little as 0·06 per cent acetic acid vapour polymerizes very rapidly when boron trifluoride is mixed with it (Curve *C*). The introduction of boron trifluoride into this isobutene – acetic acid mixture is accompanied by a dense fog and by the formation of liquid polymer throughout the whole system. The slow reaction which occurs when purified isobutene gas is mixed with boron trifluoride is shown for comparison (Curve *A*).

The action of the co-catalyst has been attributed to the fact that it forms an addition complex with the boron trifluoride, which complex then loses a proton to the olefin, thus forming a carbonium ion which can initiate a polymerization chain[2].

We have prepared a crystalline boron trifluoride acetic acid complex by mixing acetic acid vapour with excess boron trifluoride gas*. The introduction of purified isobutene gas into a system containing crystals of this complex resulted in the rapid polymerization of the isobutene. This polymerization took place entirely on the surface of the complex. Since the complex covered only a very small portion of the reaction vessel surface, the major part of this surface was completely free from liquid polymer.



A : Boron trifluoride + purified isobutene
B : „ „ „ „ + 0·01 mm. acetic acid
C : „ „ „ „ + 0·06 „ „ „

This experiment shows that in this case the polymerization of isobutene is a heterogeneous process occurring on the surface of particles of complex.

Further evidence for this conclusion was obtained by the following method. Isobutene gas, containing sufficient water as co-catalyst to give a slow reaction, was mixed with boron trifluoride in a reaction vessel (vessel 1). After 1–2 hours, this reaction mixture was expanded into a second reaction vessel (vessel 2), and the connexion between these vessels was then closed. It was found that the polymerization continued in vessel 1, but that there was no reaction in vessel 2.

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Sept. 24.

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* A crystalline complex between boron trifluoride and acetic acid has been isolated by Meerwein and Pannwitz, *J. pr. Chem.*, 141, 123 (1934).

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[2] Evans, A. G., and Polanyi, *J. Chem. Soc.*, 252 (1947).

Use of a Palladium Tube Technique in the Study of the Role of Hydrogen in Combustion Systems

From the experiments of H. B. Dixon[1] and later workers, the importance of the presence of hydrogen-containing species in the combustion of carbon monoxide is generally recognized. The wet oxidation is a chain reaction in which these bodies provide the chain carriers. Recent experiments[2,3] which prove the dominant role of the wet carbon monoxide–oxygen reaction during the high-temperature oxidation of carbon leads to a similar conclusion, namely, that small amounts of hydrogen or its compounds are necessary for the production of fully burnt gases during the combustion of solid fuels.

We have found that the stationary hydrogen concentration obtaining during the combustion of carbon

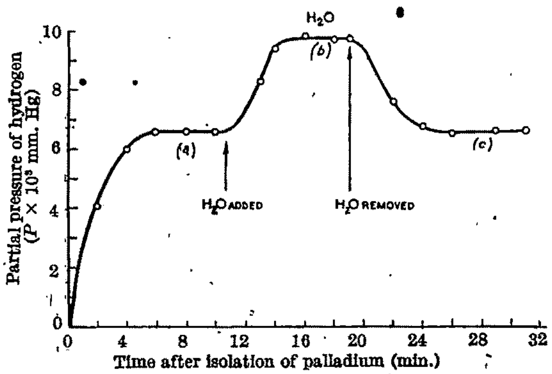

Fig. 1

monoxide – air mixtures at a jet flame may be conveniently followed by inserting an evacuated thin-walled palladium tube in the flame and observing the equilibrium pressure (due to hydrogen) set up within it[4].

In our experiments the gases were dried over magnesium perchlorate, and contained sufficient moisture to give a steady flame even when small amounts of inhibitors were present in the air. The balance of heat transferred from the flame to the palladium tube and heat lost by conduction and radiation was such as to maintain the tube at a temperature near 700° C.

We found that: (i) an equilibrium pressure was reached in 6–8 min. (Fig. 1 at *a*); (ii) the pressure within the tube responded rapidly when moisture was added to the gases fed to the flame (Fig. 1 at *b*); (iii) the diffusion process was quantitatively reversible and hence quite specific for hydrogen at the above temperatures. Fig. 1 shows at *c* that the pressure set up in the palladium tube due to addition of water vapour to the gases falls to its initial value when the water is cut off.

The equilibrium state is presumably a property of the flame alone. The approach to that state is a property of the flame, the tube, and the volume of the evacuated space. Since the reaction $H_2 \rightleftharpoons 2H$ occurs at the palladium surface, it is presumed that the measured pressure is due to the average total hydrogen concentration of the flame in contact with the palladium.

The effects of inhibitors of the combustion on the hydrogen pressure may be conveniently followed. Fig. 2 shows the influence of a minute quantity of phosphorus trichloride on the measured pressure; hydrogen chloride gives a similar result. A correlation is possible between the hydrogen content of the flame and its stability (that is, the flame speed) in the presence of the added compounds. In this connexion, it is interesting to observe that Tanford and Pease[5] have recently made estimates of the hydroxyl and atomic hydrogen and oxygen concentrations in carbon monoxide flames. They find a striking correlation between burning velocity and atomic hydrogen concentration, but little correlation with hydroxyl and atomic oxygen concentrations.

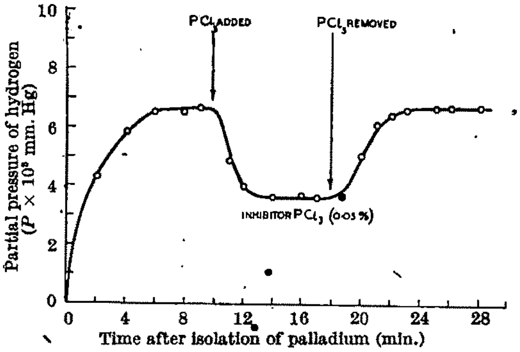

Fig. 2

It is found quite generally that those compounds which markedly increase the ratio of carbon monoxide to dioxide in the combustion of carbon[6] at 750–850° C. drastically reduce the hydrogen content of a carbon monoxide flame.

The technique is being used to investigate the effect of fine powders on combustion processes in gaseous and solid fuel systems, as part of a programme relating to the control of reactions in fuel beds. The results will be reported fully elsewhere.

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[2] Arthur, J. R., *Nature*, 157, 732 (1946).

[3] Arthur, J. R., Bangham, D. H., and Thring, M. W., *J. Soc. Chem. Ind.*, Symposium on Oxidation of Carbon, May 1947 (in the press).

[4] We were led to this technique by the qualitative observations of von Wartenberg and Sieg, B. (*Berichte*, 53B, 2192; 1920) with a platinum tube and a carbon monoxide flame.

[5] Tanford, C., and Pease, R. N., *J. Chem. Phys.*, 15 (No. 7) (1947).

[6] Ref. 3 and other unpublished data.

Nature of the Hydrogen Bond in Potassium Hydrogen Fluoride

IN 1941 Ketelaar[1] published accurate measurements on the infra-red absorption and reflexion spectra of potassium hydrogen fluoride (KHF_2). The two strong peaks of 1450 and 1222 cm.$^{-1}$ were interpreted as a doubling of the fundamental asymmetric valence frequency ν_3 belonging to the vibration of a proton between two F^- ions. The doubling was assumed to be caused by a double-minimum potential curve of the type occurring in the NH_3 molecule. The splitting of the lowest vibrational level was estimated to be 25 cm.$^{-1}$ and the distance between the two equilibrium positions 0·70 A.

On the basis of this interpretation of the spectrum one would expect, however, that the ratio of the distances between the two absorption peaks for KDF_2 and KHF_2 should be very much smaller than the value (about $2^{-1/2}$) which was found experimentally. This can be deduced from the formulæ of Dennison and Uhlenbeck[2], and is due to the fact that in KDF_2 the mass of the resonating particle is twice as large as in KHF_2. It can scarcely be expected that the change in the potential curve accompanying the substitution of H by D would compensate this effect almost exactly. Therefore, we believe that Ketelaar's interpretation of the spectra is not conclusive.

There is another criterion which may be used in order to test Ketelaar's assumption. This assumption leads to the conclusion that the dielectric permittivity of KHF_2 should be strongly dependent on temperature. This is a direct consequence of Van Vleck's principle of spectroscopic stability[3], which predicts a term proportional to T^{-1} contributing to the permittivity at temperatures large in comparison with the double minimum splitting of the lowest level; that is, the dielectric behaviour at these temperatures should be exactly as if free permanent electric dipoles were present in the crystal.

In order to test this point, Dr. Gevers and Mr. Camfferman of this Laboratory carried out some dielectric measurements on potassium hydrogen fluoride in 1945. They found that the temperature coefficient $\varepsilon^{-1}\, d\varepsilon/dT$ of the dielectric permittivity was about $+ 2 \times 10^{-4}$ in the temperature region between 80° and 300° K., while the loss angle was smaller than 10^{-3}. From Ketelaar's data one would expect a negative temperature coefficient of an order of magnitude varying from $- 10^{-2}$ to $- 10^{-3}$ in this temperature region.

We are thus in agreement with the conclusions of Pitzer and Westrum[4], who based their arguments on the absence of a heat-capacity peak in the low-temperature region.

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Reaction of Hydrogen Atoms with Solid Carbon

Avramenko[1] has recently announced the discovery of evidence for the direct reaction of atomic hydrogen with soot at a temperature of 100° C. We wish to report additional confirmation of the occurrence of this reaction in independent work which has been proceeding in our laboratory for several months.

Hydrogen atoms, produced by the standard Wood–Bonhoeffer technique[2], were pumped into a cylindrical reaction chamber of approximately 7 cm. diameter and 35 cm. length, the walls of which were internally 'poisoned' against excessive hydrogen-atom recombination by means of a coating of phosphoric acid. At an operating pressure of 0·4 mm., a 20 per cent atom concentration was readily maintained in the reactor, into the centre of which could be introduced a water-cooled glass finger thinly covered with solid reactant. Provision was made for collecting volatile products other than hydrogen by including in the exhaust system a silica gel-filled trap maintained at liquid air temperature. This method has been successfully utilized in work of this nature by several previous experimenters[3], and blank runs with hydrogen – methane mixtures in our present apparatus confirmed the suitability of the procedure. Possible higher hydrocarbons would, of course, be retained even more strongly than methane.

Runs of 45 minutes duration were carried out, in which soot deposits (made by 'smoking' the glass finger with a gas flame) were treated with hydrogen atoms. Light deposits were observed to disappear completely within a few minutes, although heavier coatings were cleaned off only partially during the reaction period. In some of the runs with heavy carbon deposits, the gaseous product exclusive of hydrogen was collected in the manner already described, and separated in part by distillation at − 185° and at − 100° C. Typical results, given in terms of c.c. of gaseous product measured at N.T.P. were as follows:

c.c. product volatile at − 185° C. (i.e., CH_4)	c.c. product volatile at − 100° C. (i.e., C_2 to C_5 fraction)	c.c. product involatile at − 100° C.	Temp. of cooling water in glass finger
6·0	0·5	nil	(uncooled)*
6·3	0·9	nil	45° C.

* No cooling water passed in this run. Temperature of sooted finger probably high, due to heat of hydrogen-atom recombination.

The experiments thus far have been of a purely exploratory nature, and a more comprehensive investigation is now in progress. The mechanism of the reaction poses an interesting kinetic problem, particularly with respect to the identity of such free organic radicals as may appear in the gas phase.

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Sept. 3.

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[1] Avramenko, L. I., *J. Phys. Chem.* (*U.S.S.R.*), 20, 1299 (1946).

[2] Farkas, A., and Melville, H. W., "Experimental Methods in Gas Reactions", 356 *et seq.* (Macmillan, 1939).

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Effect of Injection of Adrenaline on the Anaerobic Glycolysis of Rat Diaphragm

Part of the action of adrenaline in raising the blood sugar has been attributed by Cori *et al.*[1] to a decrease in utilization of glucose by the tissues. Other workers arrived at different conclusions.

For the following experiments, the anaerobic glycolysis of rat diaphragm was determined 40–60 min. after subcutaneous injection of 1 mgm. adrenaline/kgm., on the assumption that the rate of glycolysis would reflect glucose consumption in the skeletal muscle throughout the body. The Q_{CO_2} for diaphragm of adrenaline-injected animals was found to be 29 per cent inhibited as compared with controls (see table).

Rats	Average Q_{CO_2}		Inhibition (per cent)
	Untreated controls	Adrenaline treated	
Normal* (36 expts.)	2·44	1·74	29
Adrenalectomized (12 expts.)	3·38	2·30	31
Hypophysectomized (26 expts.)	2·38	2·32	0

* For every experiment two rats were used.

The failure to obtain any inhibition of glycolysis by addition of adrenaline to diaphragm or muscle extracts *in vitro* suggested an indirect action. Such an indirect action could consist in a stimulation by adrenaline of the hypophysis or the adrenal cortex, causing a release of the corresponding hormones leading to the suppression of carbohydrate utilization. A possible mechanism for this action could be the hexokinase-inhibiting effect of the hypophysis described by Colowick *et al.*[2], which effect is increased by adrenal cortical hormone and reversed by insulin.

Addition of diabetogenic hypophysis extract kindly made available by Prof. E. G. Young did not affect diaphragm glycolysis. Adrenal cortical hormone (eschatin), however, gave in nearly all cases an inhibition of 30–50 per cent. Insulin addition caused an increase in glycolysis. Since the intrinsic pituitary hormone content of the diaphragm may be optimal and since added hypophysis extract may not penetrate, these results are not in disagreement with Colowick's theory.

Next the effect of adrenaline injection was studied on the diaphragm glycolysis of hypophysectomized and of adrenalectomized animals (see table).

Adrenalectomized animals show a normal response to adrenaline injection, indicating that indirect stimulation of the adrenal cortex by adrenaline as described by M. Vogt[3] plays no part in the effect. Hypophysectomy, however, abolishes the adrenaline effect. The part played by the hypophysis could be a release of a hexokinase-inhibiting hormone under the influence of injected adrenaline, but other mechanisms, in particular pituitary influence on the action of adrenaline itself, or an active derivative, remains possible. Investigations to elucidate these possibilities are in progress, and a detailed report will be published later.

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Sept. 5.

[1] Cori, C. F., and Cori, G. T., *J. Biol. Chem.*, **79**, 309 (1928).

[2] Colowick, S. P., Cori, G. T., and Slein, M. W., *J. Biol. Chem.*, **168**, 583 (1947).

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Influence of Adenohypophysectomy on the Transfer of Salt Across the Frog Skin

IT is well known that the isolated skin of the frog is able to transport salt from its outside to the inside when bathed with frog Ringer on both sides[1]. In view of the fact that cortical hormones play an important part in the reabsorption of sodium chloride in the kidney, an investigation was made to learn whether the skin of hypophysectomized frogs, in which cortical secretion presumably is considerably decreased, is still able actively to transport salt. In specimens of *Rana temporaria* the adenohypophysis was removed, and the animals, together with unoperated controls, were kept without food in water at 10°–15° C. Three operated animals, two males and one female, of healthy appearance, were used in the experiments. The operations were carried out in November. The secretion of the skin of the operated frogs was very markedly reduced. This effect of hypophysectomy on the toad has already been described by Aubrun[2].

In May—about six months after the operation—the skin was tested (1) for ability to transport salt, and (2) for permeability to salt. Pouches made from the skin of the thigh (cf. Huf) were filled with 1·5–2 ml. frog Ringer or water and placed in small vessels containing 10 ml. aerated frog Ringer. The *p*H was kept at about 7·4, the temperature at 22° C. The passage of salt through the skin was followed either by chloride titration (when Ringer was used inside the pouch), or by conductivity measurements on the content of the pouches (when starting with water inside the pouches) using a Philip's Philoscop, A.C. 1,000 cycles[3]. Table 1 shows the result of the experiments when Ringer was applied on both sides of the skin. As was to be expected, the transfer of salt occurred from the physiological outside to the physiological inside of the skin. The results are expressed in μ mol. Cl per hour per cm.[2] of the skin. It is seen that with regard to the ability of transporting salt, no demonstrable difference exists between the skin of normal and of operated animals. Starting with water inside the skin pouch, the results given in Table 2 were obtained. The figures represent the rate at which salt was lost into the pouch. The skin of operated frogs is found to be several times more permeable than normal skin. It is therefore not surprising that the adenohypophysectomized frogs were unable to keep the chloride ion concentration of the blood at a normal level. Table 3 shows the chloride concentration in the lymph two and five months after the operation. The chloride determinations were performed on 3 mm.[3] samples of lymph taken from the lymph-sac by means of a Carlsberg constriction pipette through a small incision in the skin.

TABLE 1

	Hypophysectomized	Normal
μ mol. Cl/hr./cm.²	0·27, 0·37	0·24
	0·49	0·38
	0·56	0·54

TABLE 2

	Hypophysectomized	Normal
μ mol. Cl/hr./cm.²	0·73	0·05
	0·74	0·10
	0·82	0·13

TABLE 3

	Hypophysectomized		Normal	
	Months after operation			
	2	5	2	5
mmol./l. Cl of lymph	58	47	69	84
	64	55	75	75
	—	48	70	81

It may be concluded that the salt transport of the skin of the frog may function even in the absence of the adenohypophysis. However, directly or indirectly, perhaps via cortical action, this gland is necessary for the maintenance of the very low salt permeability characteristic of the normal skin.

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[1] Huf, *Pflügers Arch.*, **236**, 1 (1935).

[2] Aubrun, *C.R. Soc. Biol.*, **120**, 734 (1935).

[3] Barker Jørgensen, *Acta Physiol. Scand.* (in the press).

Critical Moisture Content of Dehydrated Stockfish

INVESTIGATIONS conducted in this Laboratory into the dehydration of stockfish (*Merluccius capensis*) have indicated that the moisture content of the dried product has a great influence on its keeping quality.

Whereas such products as dehydrated vegetables, dried fruit, dried whole milk and dried eggs have their storage life lengthened with reduction of the moisture content of the dried product, the reverse relationship has been found to hold for dehydrated stockfish.

Below 8 per cent moisture content, there is a sharp reduction in the storage life of dehydrated stockfish with every decrement in moisture content. The deterioration takes the form of both discoloration and loss of flavour. The re-incorporation of the liquid extracted from the flesh during the preliminary cooking of the flesh by steam also retards the rate of deterioration, but not sufficiently to give an effective storage life. With increasing moisture content above 8 per cent there is still evident a small improvement in quality of the dried product up to the moisture limit where spoilage by micro-organisms intervenes. The improvement per increment of moisture content is small above 16 per cent moisture content.

The storage life of the dehydrated product packed in an inert atmosphere with moisture content less than 5 per cent is approximately six weeks, and with a moisture content of 16 per cent it is up to twelve months.

The reversal of the relationship that exists between moisture and deterioration in other dehydrated products is of considerable interest in view of the fact that many laboratories are searching for clues as to the nature of the deterioration that takes place in dehydrated products.

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Cobalt Deficiency in Sligo

ON a farm on sandy soil in Co. Sligo where sheep pine and die, and cattle show pronounced ill-health, the administration of cobalt to the stock restores health and increases productivity to a remarkable degree. The herbage is definitely deficient in cobalt. The stock on this particular farm are confined to it, while the stock from neighbouring farms in which the pronounced cobalt deficiency symptoms do not appear have alternative pastures.

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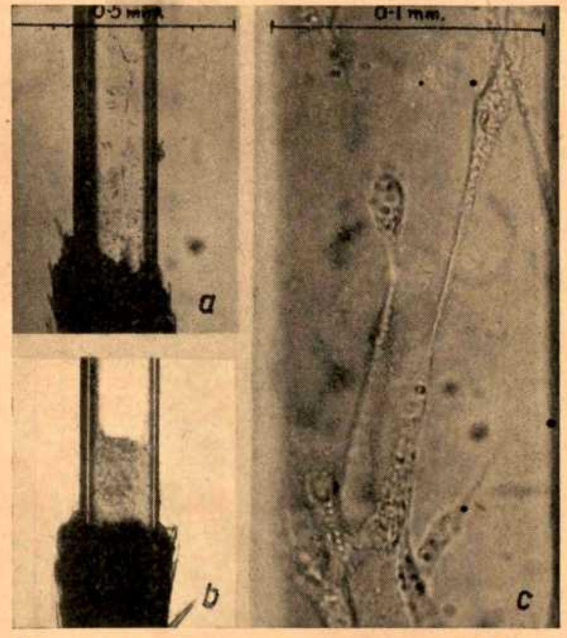
A Method for Observing Growing Epithelial Tissue in *Rhodnius prolixus* (Hemiptera)

ALTHOUGH it has been accomplished in the case of the hæmatocytes and imaginal disks of *Drosophila*[1], the cultivation of insect tissue *in vitro* has proved to be very difficult. A method by which growing epithelial tissue can be observed in transmitted light, while still in connexion with the hæmolymph and the epithelium of the living insect, may therefore be of general interest. The method is based on the fact that epithelial cells, after injury, will grow along any surface, and that if a wound is covered with glass, the cells will spread rapidly on the surface of the glass[2].

A hind leg of a freshly fed fifth-stage nymph of *Rhodnius* is amputated in the distal part of the tibia. A fine glass tube about 2 mm. long and 0·15 mm. thick is then introduced into the opening of the tibia, so that it is covered for about 0·2 mm. of its length by the cuticle. This operation is made while the leg is immersed in Ringer solution. The Ringer solution is then withdrawn and the distal end of the capillary tube sealed with paraffin wax. For the observation the insect is fixed on a special slide. The treated leg is immersed in water and covered with a cover-slip. For observing with the oil-immersion objective, the leg is imbedded in paraffin wax of low melting point up to the amputation level and the glass tube immersed in golden syrup. By this means excellent optical definition of the cells growing on the upper surface of the tube can be secured. At a temperature of 25° C. this preparation can be kept under quite normal physiological conditions for about twenty-five days, that is, until the insect moults. It is very sensitive to heat and to strong illumination.



PHOTOMICROGRAPHS OF CULTURES OF LIVING EPITHELIAL TISSUE IN *Rhodnius prolixus*. (*a*) EARLY STAGE (TWO DAYS) WITH HÆMATOCYTES AND FEW EPITHELIAL CELLS. (*b*) LATE STAGE (NINE DAYS) WITH CONTINUOUS EPITHELIUM. (*c*) SOME EPITHELIAL CELLS FOUR DAYS AFTER THE OPERATION

In a fresh preparation a great number of hæmatocytes can be observed. They are spherical or elongated while floating freely in the hæmolymph, but become more elongated and flattened when they attach themselves to the walls of the glass tube. Many cell divisions can be observed in hæmatocytes in the first days, but after five to six days they become vacuolated and degenerate very quickly, leaving behind little droplets.

After the first 12–14 hours the first epithelial cells migrate into the visible part of the tube. They are closely applied to the wall of the tube and move by extending and withdrawing pseudopodia. They are always connected with each other and with the epithelium of the leg by long, highly birefringent protoplasmic threads. The cells move at a speed of 30–40 μ per hour, so that after another twenty-four hours they may cover almost 1 mm. of the tube with a sparse network of cells, interconnected by protoplasmic processes. The movements of the single cells can easily be followed and many details observed. The addition of a green filter increases the visibility of the nucleus. Although at first the cells move only along the walls, the protoplasmic threads connecting them can loosen themselves from the wall and run right across the lumen of the tube. Other cells can then migrate along these threads, so that after a time these paths often become densely crowded. After about seven days, many cells congregate at a distance of about 0·5 mm. from the amputation-level. The empty proximal regions then gradually become filled up with cells, but the more isolated cells in the distal part of the capillary begin to degenerate. A continuous epithelium which covers about 0·3–0·5 mm. of the tube will be formed by the tenth day, and after that only cell divisions occur. The preparation is then no longer suitable for the observation of single cells. Nevertheless, I hope that the method will be of use in investigating the laying down of the new cuticle of the regenerating leg.

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Sept. 9.

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Economic Control of the Relapsing Fever Tick in African Houses

The control of the relapsing fever tick, *Ornithodoros moubata* Murray, which is widespread and alarmingly abundant in many townships and labour camps in East Africa, has hitherto proved uneconomic, owing to the marked resistance of the species to the common insecticides, and the consequent heavy dosage required. I have recently had occasion to carry out trials on a practical scale with a number of 'Gammexane' formulations, and the results have been so promising that it was thought opportune to bring the details of a simple method of treatment to the notice of all who are interested in the control of ticks.

It is a matter of simple experiment to demonstrate the outstanding toxicity of hexachlorocyclohexane to *O. moubata*. Individuals subjected to the lightest dusting with a commercial dust containing 0·5 per cent of 'Gammexane' begin to lose their power to co-ordinate leg movements after 4–6 hours. They may lose up to 10 per cent of their body weight in twenty-four hours by excessive coxal secretion, by defæcation of milky fluid, and probably also by increased permeability of the tough integument. There is in many cases a darkening of colour, due to the diffusion of ingested hæmoglobin compounds from the gut to the body cavity. The ticks become immobile, except for feeble but persistent, and sometimes rhythmical, leg movements, after periods varying from twelve hours to five days, according to age, and mortalities of 80–100 per cent result after 8–10 days. In the case of adult ticks, and particularly of gravid females, individuals have shown leg movements up to two months after treatment, but any eggs laid have invariably failed to hatch. The parallel action of D.D.T. 5 per cent dust is slower and less effective, although mortalities of 50–80 per cent have been secured after more than twenty days.

In the field, the most economic treatment has proved to be the 0·5 per cent 'Gammexane' dust, applied directly to the floors and the first few inches of the walls of infested houses. Application is made with a simple shaker such as a cigarette tin of the circular type, at the rate of 3–4 lb. of dust per 1,000 sq. ft. of surface. The results are checked by a standard system of survey, in which a team of five 'boys' searches the floors to a depth of 1½ in. at random for five minutes. By this means, the infestation figures in a labour transit camp have been reduced from an average of 20 per unit sample to less than 0·2 over a period of nine months. There was evidence that re-treatment was required after this time, possibly owing to consistent re-infestation from transit labourers, who commonly carry the ticks in their bedding.

Since the cost of the material used, if prepared by the dilution of the commercial dust concentrate (2·5 per cent 'Gammexane') with a local diluent, of which the best appears to be a light diatomaceous earth ('Diatomite'), is in the region of 4·5*d.* per lb., this treatment should be well within economic bounds for large-scale application. These experiments have been extended to cover an entire township, consisting of approximately 1,200 houses, 50 per cent of which are infested with *Ornithodoros*, with consequent high incidence of relapsing fever. It may be some time before the effect on fever statistics can be assessed, but the relief from the ticks is already widely appreciated, and the treatment has been officially standardized in several departments in Tanganyika as an advance on any control method previously known.

I am indebted to the Director of Agricultural Production for permission to publish this note.

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Aug. 20.

Geological Age: the Extreme Antiquity of Pegmatites from Manitoba

An inspection of the available data on geological ages determined by the lead method shows that in two areas the pegmatite ages appear to be considerably greater than those of any other Pre-Cambrian pegmatites so far determined. These two areas are located in northern Karelia and south-east Manitoba, Canada.

The geological age of pegmatites from northern Karelia is quite often held to be the greatest age so far determined. Several specimens of uraninite have been analysed[1] and the ages, which have been recalculated here with the aid of Wickman's graphs[2], are invariably nearly 1,800 × 10^6 years, which is the mean of all the determinations. Some specimens of monazite have also been analysed[1], and although the age of each specimen is about the same (average 2,100 × 10^6 years), it is somewhat higher than the uraninite age. From these data, the probable age of the pegmatites from northern Karelia is therefore about 1,800–2,100 × 10^6 years. Unfortunately, no isotope analyses of the lead in these specimens are known, and it has thus not been possible to compute ages according to Pb^{206}/U^{238}, Pb^{208}/Th^{232} and Pb^{207}/Pb^{206} ratios, which would provide valuable evidence in support of, or against, the above ages for the northern Karelian pegmatites.

Two specimens of uraninite and two of monazite from Manitoba pegmatites have also given high ages, which, recalculated as stated above, range from 1,700 to 2,000 × 10^6 years. Lead from one specimen of uraninite and one of monazite has been analysed on the mass spectrograph, and serious discrepancies have been found in the 'ages' of these specimens according to whether the ages are calculated by Pb^{206}/U^{238}, Pb^{208}/Th^{232} or Pb^{207}/Pb^{206} ratios. These ages, taken from Nier[3,4], are given in Table 1.

Table 1

No.	Mineral and source	Pb^{206}/U^{238} age	Pb^{208}/Th^{232} age	Pb^{207}/Pb^{206} age
1	Uraninite, Huron Claim, S.E. Manitoba	1570 × 10^6 yr.	1252 × 10^6 yr.	2200 × 10^6 yr.
2	Monazite, ,,	3180 ,,	1830 ,,	2570 ,,

Nier[4] has pointed out that the Pb^{207}/Pb^{206} ages are quite likely to be the most reliable, and the agreement between the Pb^{207}/Pb^{206} uraninite and monazite ages given above is reasonably good. Consequently, although serious discrepancies are apparent, the agreement between the Pb^{207}/Pb^{206} ages indicates quite strongly that the age of the pegmatites from south-east Manitoba is one of the greatest yet reported.

Age determinations using the strontium method support this evidence. (For age determinations calculated according to strontium – rubidium ratios, a value of 5·8 × 10^{10} years, determined by Eklund[5], has been used for the half-life period of Rb^{87}.)

First, Strassmann found approximately 2·6 per cent rubidium and 0·155 per cent strontium, more than 99·7 per cent of which was found to be radiogenic[7] in lepidolite from the Silver Leaf Mine, south-east Manitoba, whence the strontium age is calculated as 1,830 × 10^6 years. However, some strontium may have been lost during analytical manipulations, and may be as much as 10 per cent[8], in which case the strontium age would be 2,000 × 10^6 years.

Secondly, using a spectrochemical procedure described elsewhere[9], strontium ages of four different specimens of lepidolite from south-east Manitoba have been determined (Table 2).

TABLE 2

No.	Source	Strontium age
1	Falcon Island, Lake of the Woods, S.E. Manitoba	2200 × 10^6 yr.
2	Along the Winnipeg River, ,,	2300 ,,
3	Silver Leaf Mine, along Winnipeg River, ,,	2100 ,,
4	,, ,, ,, ,, ,, ,, ,,	2350 ,,

(Probable experimental error in each case about ± 15 per cent.)

These ages agree satisfactorily and are also in reasonable agreement with the other ages that have been discussed. It might be argued that as no isotope data on the strontium in these specimens are available, contamination by ordinary strontium is possible. This possibility cannot be overlooked, but the evidence against it is very considerable. First, available mass spectrographic analyses (seven in all)[10,11] have shown radiogenic strontium to predominate in lepidolite. Secondly, the ages of about twenty-five specimens of lepidolite from various localities and of different ages have been determined[12], and with few exceptions no contamination is apparent. These ages include those of Pre-Cambrian pegmatites from New Mexico, Colorado, South Dakota and Ontario, all of which are of the magnitude of approximately 1,000 × 10^6 years and are only about half the Manitoba age. Thirdly, two of the above specimens are from the same pegmatite (Silver Leaf Mine) from which the specimen containing more than 99·7 per cent radiogenic strontium was taken; and fourthly, had contamination been significant, it is highly unlikely that agreement so close as that shown in Table 2 could occur.

A consideration of the ages given in Table 2, as well as of others that have been discussed, seems to establish beyond reasonable doubt that the pegmatites from south-east Manitoba are of extreme antiquity, and that with the possible exception of the north Karelian pegmatites, which may be of about the same age, they represent the most ancient portion of the earth's crust, on which it has been possible to determine the geological age. An age of 2,100 × 10^6 years is considered reasonable for these pegmatites.

The granites from south-east Manitoba with which the pegmatites are associated are intrusive into an ancient complex, referred to by Wright[13] as the Rice Lake Series, which is composed of various types of lavas, sediments—some of which contain pebbles of a still more ancient granite—and metamorphosed equivalents. The history of the Series appears to have been quite extended. Consequently, some support is given to Holmes'[14] estimate of 3,350 × 10^6 years as the age of the earth, rather than an age of 2,000 × 10^6 years which is sometimes considered to be the most probable age.

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Aug. 26.

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Text-book Organic Chemistry

No author or editor, unless claiming omniscience, completes a text-book on organic chemistry without feeling that sprinkled through his text are erroneous, inaccurate or ambiguous statements. To confirm his forebodings comes the letter from Prof. C. K. Ingold[1] and his colleagues with the above slightly unkind title, conveying the impression that text-books often contain a peculiar if not spurious brand of organic chemistry: "clauts o' cauld parritch", as Andrew Fairservice described another kind of doubtful doctrine. But surely the tone of the letter is in places exaggerated. Neither error quoted constitutes a "howler" or solecism; and far from being "inexcusable" it is easy to understand that, despite all vigilance, erroneous statements should sometimes be made or repeated, especially should they enjoy the sanction of authoritative reference books such as Heilbron's "Dictionary".

Nevertheless, Prof. Ingold's letter is salutary and is to be welcomed, both for raising an important problem and for contributing towards its solution. It is to be hoped that students, teachers and research workers will assist authors to overcome sins of omission and commission, either by private letter or by communication to appropriate journals. In the latter case, may the plea be made for publication in a prominent and accessible form. Prof. Ingold's letter complies with this requirement: his previous communication[2] on the same subject, consisting of a few lines in the middle of a longish, partly polemical paper, does not.

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ARCTIC AEROBIOLOGY

By Prof. NICHOLAS POLUNIN, Prof. S. M. PADY and Prof. C. D. KELLY

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SO far as we are aware, the only published observations on the presence of micro-organisms or spores in the atmosphere overlying arctic regions are those of Meier[1,2], who investigated petrolatum-coated slides exposed by Colonel Charles A. Lindbergh during his flights over southern and central Greenland, etc., in the summer of 1933. Meier's preliminary account[1] indicated that a considerable diversity of biota was represented on Lindbergh's slides, which in most instances had been exposed for at least an hour above 2,000 ft. from an aircraft travelling at an airspeed of 110 m.p.h. Unfortunately Meier lost his life in a flying accident before the promised detailed account of this interesting material could be written. He did, however, remark[1] that in spite of the nutritionless surface "Some of the spores of fungi caught at different points show definite evidence of having been alive when trapped. . . . The potentialities of world-wide distribution of spores of fungi and other organisms caught up and carried abroad by transcontinental winds may be of tremendous economic consequence."

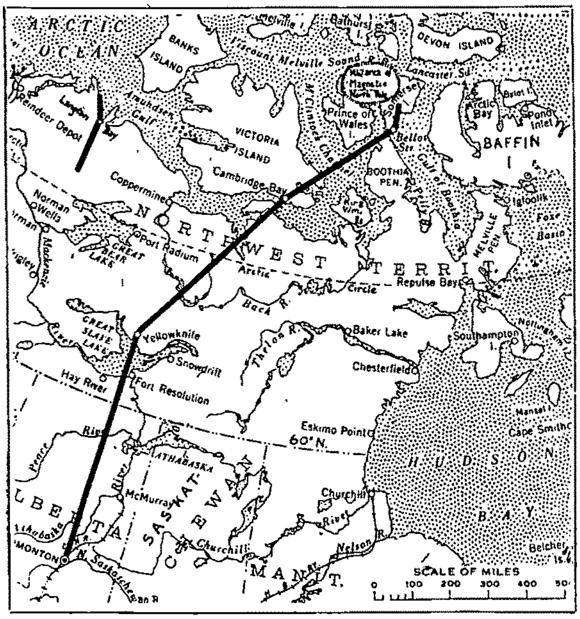
It was also in 1933 that one of us (N. P.) exposed nutrient Petri plates on mountain tops in northern Lapland under winter conditions, and later in Spitsbergen during the summer. But with the protracted travels and rough treatment which the plates had undergone, and the crudity of the only methods of incubation available in the field, it was felt that the unexpected number of fungal and bacterial colonies observed in some cases after only brief exposure might be due to contaminations, and so no account was published. Indeed, no reliance could be placed on these 'observations', as many of the plates appeared to be far from sterile before exposure, while in others the medium had become hardened through loss of water. However, the attempts are mentioned here as they appear to represent the first (albeit abortive) ones of their kind in the arctic and already give some suggestion of relatively abundant life in its atmosphere.

During August and September 1947, one of us (N. P.), while flying with the Royal Canadian Air Force on operations concerned primarily with geographical survey work and locating the north magnetic pole, took the opportunity of exposing from his aircraft considerable numbers of nutrient Petri plates and 'Vaselined' microscope slides especially prepared under the direction of another of us (S. M. P.). The medium employed on the plates was Czapek's solution agar with sugars omitted but with the addition of 1·0 gm. of yeast extract per 1,000 c.c., allowing only very slow growth and consequently temporary storage of the plates in the field. Two batches of nutrient plates were used in the investigation, the first being taken up with the main expedition in June, and the second being flown into the field in July. Contaminations developed in some of the plates of the first set, and these contaminated plates were consequently discarded; the second set, on the other hand, did not develop any contaminations whatsoever. Moreover, all the seven unexposed plates proved to be sterile even after they had been returned to the laboratory and incubated in mid-September. A total of fifty-one plates and fifty-two slides were exposed.

Each plate was doubly wrapped in wax and tissue papers, and was unwrapped only just before, and rewrapped immediately after, exposure, which was entirely outside the aircraft. All wrappings were secured with rubber bands, and except during exposure each cover was attached to its plate by adhesive tape, which also proved convenient for labelling purposes. An exposure was effected by thrusting the unwrapped but still covered plate in the right hand from a partially open window on the starboard side of the aircraft, holding the plate with the nutrient surface orientated vertically and hence 'flat' against the air-stream at least eight inches from the nearest point of the fuselage, then easing off the cover with the left hand and sliding it away down the right wrist and forearm, which were thus made to withstand the pressure of the air on the left hand holding the cover. The exposed plate was thus held against the full force of the airstream for precisely two minutes, after which it was covered by a reversal of the previous operation of the left hand and then brought into the aircraft to be finally labelled and wrapped. With the method evolved and precautions taken, and as was indicated by the seven controls mentioned above, there seems virtually no possibility of more than an occasional contamination.

The 'Vaselined' slides were kept in individual, specially constructed cardboard and adhesive-tape containers separately wrapped in wax paper which allowed no access of air currents until they were opened before placing the whole in a special wooden-handled, copper holder in which the sticky surface was exposed against the air-stream for five minutes in about the same position outside the aircraft as the nutrient plate: indeed, each slide and plate formed a pair, being exposed either contemporaneously or consecutively according to the type of aircraft and facilities immediately available.

Except for inevitable gaps due to liquid or ice precipitation or to preoccupation with landing, etc., a plate and a slide were exposed either every twenty or every thirty miles, approximately, throughout the flights concerned. The first of these flights was on August 12, and extended in a northerly direction from a base-camp situated on an unnamed lake north-west of Great Bear Lake to Langton Bay on the Arctic Ocean coast, and thence in a north-westerly direction to the mouth of the Horton River near Cape Bathurst, the most northerly point of the western Canadian mainland. These early exposures (numbers 1–11) were made at approximately twenty-mile intervals from the side of a 'Norseman' aircraft fitted with floats and may have been affected by bodies adhering to the fuselage or by the turbulence caused by the single propeller situated ahead of the nose, although such a possibility has been largely discounted by others[1,3]. The later exposures, comprising the vast majority in all, were made from the co-pilot's seat of a 'Canso' flying-boat of which no part lay directly ahead: the propellers stood above and well behind, and the smooth nose was situated so far below and to the side of the point of exposure that the air-stream in normal circumstances seemed entirely steady and direct. These later exposures extended over about 1,500 miles from Somerset Island southwards to Edmonton, Alberta, and were made up of three groups on flights as follows: (1) on August 26, at approximately twenty-mile intervals from Cambridge Bay, Victoria Island, in a north-easterly direction to the south end of Somerset Island, then northwards until bad weather intervened in about latitude 73° N.; (2) on August 27 at approximately thirty-mile intervals from Cambridge Bay in a south-south-westerly direction to Yellowknife, Northwest Territories; (3) on September 5, at approximately thirty-mile intervals, from Yellowknife southwards to Edmonton. These flights, on which plates and slides were exposed, are indicated on the accompanying sketch-map.



Most of this 1947 exposing was done at or around an altitude of 5,000 ft. and airspeed 100 knots (115 m.p.h.). Details were also kept, or are being worked out, of other conditions such as wind, cloud, icing, geographical position, etc., and it is hoped through official channels to gather together sufficient extra-continental meteorological data on the 'upper air' movements of these and preceding days to get some indication of the general region of origin of the air-masses in and below which the plates and slides were exposed. Meanwhile the slides are being sent to specialists to examine for stem and leaf rust of wheat and other pathogen spores, pollen grains, etc., while we are dealing in the first instance with the considerable range of Fungi and Bacteria that are represented on the plates. Indeed, whereas we had expected few or no colonies to develop on incubation of the plates that had been exposed in the far north, for example, over the ice-fields of M'Clintock Channel, we found that almost all on return bore numerous and various colonies of Fungi and Bacteria, indicating both these groups to be abundantly and diversely represented in the arctic atmosphere. As examples we may note that plate No. 25, exposed at 4,000 ft. over the south coast of Somerset Island around latitude 72° N. and longitude 94° W., shows a total of 102 colonies of Fungi and 89 of Bacteria, while plate No. 17, exposed at 4,400 ft. over the sea-ice of M'Clintock Channel, shows 7 colonies of Fungi and 95 of Bacteria. On the other hand, plate No. 24, exposed only ten minutes earlier than No. 25 and in essentially the same region, shows only 8 fungal and 74 bacterial colonies.

Determinations and other details will take a considerable time to work out; but we would like meanwhile to report this unexpected indication of abundance of life in the arctic air and say that we hope to extend these studies in the future, and request news of any connected work.

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DIELECTRIC RESIDUAL EFFECTS IN TITANATES

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BARIUM TITANATE and certain related compounds having structures of the perovskite type possess exceptionally high permittivities which rise to a maximum at certain characteristic temperatures, a transition taking place from a distorted to a cubic crystal structure. The permittivity – temperature relation depends primarily on the particular material used, but is influenced also by the method of preparation, especially by the temperature at which the ceramic is fired. It has been shown that barium titanate is ferro-electric below the temperature corresponding to its permittivity maximum[1,2], and in this connexion a study of the changes with time in the permittivity and dielectric losses after a high, unidirectional electric field had been applied to materials of this type, which is now described in outline, may be of interest.

The experimental method consisted in maintaining the samples at different temperatures and determining the permittivity and dielectric losses before, and at various times after, the application of a strong D.C. field. Accurate temperature control was essential owing to the high temperature coefficient of permittivity, and a special thermostat arrangement was used, comprising a small metal chamber containing the sample, through which dried air at a constant temperature was passed. The permittivity and losses of the dried solid were determined at a frequency of 1 kc./s. and measuring tensions not exceeding 5 V./3 mm. Immediately after the application of the high tension, the electrodes of the samples were in all cases connected to earth for some seconds.

Barium titanate and a number of mixed titanates were examined, and it was found that below the temperature corresponding to the permittivity maximum, $T_{\varepsilon \max}$, the permittivity, shortly after the application of a high tension, had a value 3–6 per cent above that prior to treatment, and reverted at first rapidly, later more slowly, to its original value. The total time of decay varied from 10 to 50 min. from the time of cessation of the high tension.

Figs. 1 and 2 show the type of curves obtained for samples A and B, consisting of barium titanate with a permittivity peak at 112° C., and a mixed titanate with a maximum at 50° C., respectively. The effect became more pronounced at higher temperatures, being largest at a temperature just below $T_{\varepsilon \max}$. The time of reversion to the original permittivity was increased by prolonging the period of application of the tension. In the case of barium titanate, effects

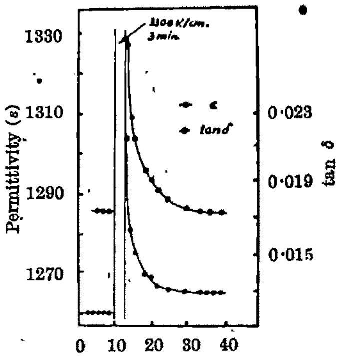

Fig. 1. SAMPLE *A*: TEMP. 24° C.; D.C. FIELD, 3300 V./CM., APPLIED FOR 3 MIN.

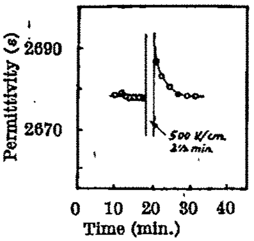

Fig. 2. SAMPLE *B*: TEMP. 24° C.; D.C. FIELD, 500 V./CM., APPLIED FOR 2½ MIN.

of the same type were observed at temperatures corresponding to the portion of the plateau in the permittivity – temperature curve in which the temperature coefficient is slightly negative (that is, between 20° and 45° C.), and in the regions where the coefficient is positive. The dielectric losses and permittivity in each case varied in a similar manner, approaching very nearly their original value after a period of 10–50 min.

At temperatures above $T_{\varepsilon\max}$, the permittivity was smaller immediately after the cessation of tension and reverted slowly to its original value, the effect being largest in the case of higher tensions and prolonged periods of application. Figs. 3 and 4 show typical curves obtained for sample *C* consisting of barium strontium titanate ($BaTiO_3 : SrTiO_3 = 75 : 25$, by weight; $T_{\varepsilon\max}$: 21·5° C.), and sample *B* ($T_{\varepsilon\max}$: 50° C.). Analogous results were obtained with all the compositions examined, the only exception being sample *C* at a temperature just above $T_{\varepsilon\max}$, which showed a temporary increase in permittivity. The loss tangent, being low beyond $T_{\varepsilon\max}$, remained constant at a value of 0·0025 and 0·001 in the case of samples *B* and *C*, respectively.

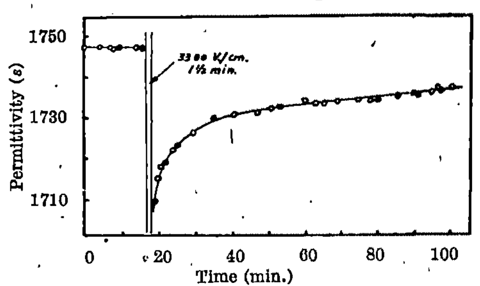

Fig. 3. SAMPLE *C*: TEMP. 70° C.; D.C. FIELD, 3300 V./CM.; APPLIED FOR 1½ MIN.

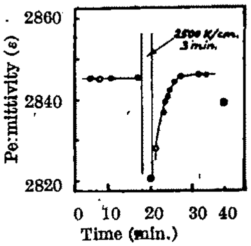

Fig. 4. SAMPLE *B*: TEMP. 80° C.; D.C. FIELD, 2500 V./CM., APPLIED FOR 3 MIN.

It is seen that, within the temperature range corresponding to the distorted perovskite structure, a temporary increase in permittivity was obtained, while in the region of the cubic structure a temporary decrease was generally observed. A possible explanation for the increase at a temperature just above $T_{\varepsilon\max}$ in the case of sample *C* may be that the two structures co-exist within a temperature range extending slightly beyond $T_{\varepsilon\max}$[3,4], the effect due to the distorted structure being the larger one.

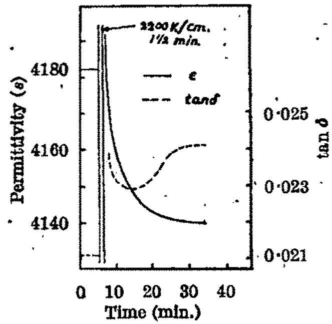

Fig. 5. SAMPLE *D*: TEMP. 30° C.; D.C. FIELD, 2200 V./CM., APPLIED for 1½ MIN.

At a temperature below $T_{\varepsilon\max}$, a third effect was observed in the case of some compositions after the application of tensions higher than those resulting in the temporary increase in the permittivity only. Under these conditions, the permittivity approached asymptotically an apparently permanent lower value. Fig. 5 shows this effect, combined with the initial temporary increase, for sample *D* having a permittivity maximum at 50° C.

A fuller account of the work will be published later.

We are greatly indebted to the United Insulator Co., Ltd., Surbiton, for generously giving us facilities in their Research Laboratory.

[1] *J. Phys., U.S.S.R.*, **10**, 95 (1946).
[2] *Ind. Eng. Chem.*, **38**, 1097 (1946).
[3] *Trans. Farad. Soc.*, **42**, 224 (1946).
[4] *Nature*, **160**, 58 (1947).

INTERNATIONAL TIMBER CONFERENCE

A REPORT has been issued of the International Conference on Timber held at Marianski Lazne, Czechoslovakia, during April 28–May 10, 1947, under the auspices of the Food and Agricultural Organisation of the United Nations (Washington, D.C.: Food and Agriculture Organisation. 50 cents). These discussions, the first comprehensive discussions of timber and forestry to be held in Europe since the end of the War, have shown that the nations represented were in unanimous agreement on a variety of issues. The Conference did not attempt to solve all the problems of forests and timber in Europe, but confined its attention to more limited objectives and admitted that, even with respect to these, its recommendations were only a starting point.

It is well known that post-war Europe is confronted with a grave timber problem. It is not a matter, as some appear to think, of merely seeking out accessible sources of supply and cutting the forests down. The large excess fellings and destruction committed during the War has led to a serious position in parts of Europe and outside Europe. Excess fellings—cutting out more than the annual increment of one or more years—means in the end the disappearance of a forest. Even to supply the well-known needs for timber of large populations we should not be justified in dooming forests which should be maintained in the interests of posterity and often for reasons quite other than timber alone.

For Europe alone it was known that more timber annually is required than pre-war Europe used; yet the soft-wood timber supplies are below the average of the year before 1939. This is delaying reconstruction. Methods of bridging the gap, it was realized, appeared to be not only inadequate but also difficult to achieve; there was also the fear that repercussions might lead to an even more serious crisis in the future; in other words, over-cutting after the drain imposed on the coniferous forests during the War might lead to lasting damage to the surviving European forests. The second alternative appeared equally difficult: a reduction in timber consumption was equally undesirable, since it is in apparent conflict with improvement in housing and living standards which has been adopted as a primary objective by the United Nations Organisation. The Conference approached this matter by dividing it into three parts: (1) short-term problems; (2) long-term problems; and (3) further procedure; and the three chapters of the report deal with the problems in this manner.

The Belgian delegate reported on savings effected by substituting other materials for lumber. A memorandum was submitted by the United Kingdom on economy and the uses of timber, including restrictions and the fixing of maximum sizes in which timber is to be used for joists, rafters, floor-boards and so forth. Some of these restricted efforts, it may be said, have not proved very satisfactory, and do not help in reconstruction on the countryside.

A note had been drawn up by the Food and Agriculture Organisation Preparatory Commission on World Food Proposals, and briefly this report stated that the timber situation presents the same problem which has confronted the Commission in regard to several other commodities with, says the report, "the important difference that as food scarcities begin to subside, the world-wide timber shortage is becoming more serious".

It is suggested in the present report that a better organisation for distribution and allocation, by transport and credit facilities, would assist in some degree; the introduction of technical improvements in order to ensure better utilization of available timber supplies would also be valuable.

There is another resolution submitted by the Economic and Social Council of the United Nations, recognizing the seriousness of the present timber shortage in Europe which threatens to delay economic recovery, and this resolution welcomes the initiative taken by the Food and Agriculture Organisation. It is not possible here to deal in detail with all the resolutions and recommendations adopted by the Conference; but briefly they refer to various details in forest management and to the necessity for dealing with the world-wide shortage of timber in such a manner that serious depredations will not be made on the forests, which would result in their destruction. It is also recommended that proper organisation and proper technical methods should be introduced into the management of forests, and having regard to the long period required for the development of forest resources and for the fulfilment of domestic rational forest policies, it is considered desirable "that the European countries concerned should meet together from time to time to exchange information and views about their problems in the field of medium- and long-term forestry. F.A.O. under its existing mandate is able to call together consultative committees, and it would seem appropriate therefore that F.A.O. should consider providing such a committee on forestry within its framework. It could meet from time to time as might seem necessary in the opinion of F.A.O. and of the governments concerned acting in close consultation."

E. P. STEBBING

SCIENTIFIC APPROACH TO THE LACE INDUSTRY

IN its treatment of scientific and technical research and development, the report of the Board of Trade Working Party on the Lace Industry[*], of which Miss L. S. Sutherland was chairman and the late Prof. J. M. Gulland a member, follows similar lines to earlier reports from 'working parties' dealing with other textile industries. Like most of the latter, the machine-lace industry grew out of a craft, that of traditional hand-lace, and was not born of scientific research. In addition, it has always been, and still is, essentially a cotton industry, and in its essentials the industry remains the same as in the days of our grandfathers.

Speaking in very broad terms, in the past the lace industry in Britain has shown little interest in research. The total expenditure by individual firms on research appears to be small, and contribution to co-operative research by membership of research institutes such as the British Cotton Industry Research Association was by no means universal although fairly common. In spite of signs of a changing attitude in recent years, the 'working party' attributes many of the present urgent problems of the industry to its failure over a long period to investigate systematically and scientifically the textile, engineering and other aspects of the trade, not least important being those affecting health. One of the strongest recommendations in the report is, in fact, that the newly formed Research Council for the industry should press forward its investigations into a satisfactory substitute for graphite, the use of which as a lubricant for lace machines has given the machine-holding sections the character of a 'dirty trade'.

In characterizing the lace industry as a whole with indifference to research, with neglect of fundamental research and with a marked tendency for whatever research is prosecuted to be sporadic, and noting the absence of research staff and, except in the dressing section, even of scientific staff, the 'working party' frankly recognizes that no industry could achieve products of such technical excellence as lace fabrics without a background of continual inquiry and trial. None the less, it is questionable whether inquiries into the use and handling of different yarns have in general been prosecuted with sufficient system to yield their full potential value. Investigations are frequently short-term projects to solve specific production problems, and are shelved when these have been overcome sufficiently for the immediate needs.

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[*] Board of Trade. Working Party Reports: The Lace Industry. (London: H.M. Stationery Office, 1947.) 3s. 6d. net.

Valuable services have indeed been rendered to many firms by the Textile Testing Department, until very recently a part of University College, Nottingham, and by several research associations, but the 'working party' suggests that there are at least four factors restricting the development of research in the industry as a whole. As in the cotton industry, there has been lack of contact between the machine-holders and the machine-builders; the industry is almost entirely lacking in scientifically trained personnel in its higher ranks; the intense individualism of the industry has prevented a united approach to technical and other mutual improvements; and lastly, many machine-holders have taken a narrow view of their functions—to regard their function as limited to processing yarn supplied to them in a finished state with machinery planned and built by others, and to consider in consequence that little or no investigation is required of them other than innovations in design and yarn utilization, and handling.

These factors have to some extent been weakened by experience gained in co-operative research and production during the War, and the formation in January 1944 of a Technical and Research Committee of the Federation of Lace and Embroidery Employers' Associations led in June 1945 to the formation of a Lace Research Council, consisting of the members of the former Committee and the professors of botany (industrial mycology), chemistry, electrical engineering, physics and textiles of the University College of Nottingham. The Federation, however, was not disposed at that stage to establish a research association under the Department of Scientific and Industrial Research, but having guaranteed an income of £2,000 per annum for a period of three years, the Federation approached the latter Department to obtain Government assistance. As a result of this approach, the Research Council will have at its disposal a total income of £4,500 per annum during the three-year period and has already appointed as liaison officer in research matters a chemist of long experience of textile processes. The Council has, however, no laboratories and the duties of this solitary scientific officer are in the first place confined to formulating the problems and conditions facing the industry, maintaining contact with research associations and inaugurating investigations under contract at universities, technical colleges and elsewhere, and to the dissemination of information.

That, broadly, is the position which the 'working party'—whose conception and differentiation of research is in line with those detailed in the report of the Cotton Working Party—seeks to meet by what has now come to be the customary prescription of 'working parties', namely, a compulsory levy. It does not, indeed, suggest that a compulsory levy should be made solely for scientific and technical research: it is also intended to cover the financing of economic and market research, the promotion of overseas sales and the establishment of a design and fashion centre. The 'working party' does not go further than to suggest that the question whether the industry can afford not to inaugurate a fully fledged research association with its own staff, laboratory and workshop should be under constant review. It does not appear, however, to have contemplated any alternative to the usual research association for an industry in which much educational work is imperative before support can be won for research, and utilization of the results of research ensured.

COLOUR PHENOMENA IN THE PERCEPTION OF FINE DETAIL

In a recent memoir, "The Visual Perception of Fine Detail", Prof. H. Hartridge has discussed the way in which "the image formed on the retina is clarified and improved before it reaches the higher centres of the brain", and considers in particular the reason why objects in white light are not seen surrounded by the coloured fringes which are certainly produced by the aberrations of the dioptric system of the eye (*Phil. Trans. Roy. Soc.*, B, **232**, 519; 1947). To throw light on this question, observations were made of the changes in apparent colour of coloured test objects, in some cases monochromatic stimuli, when their angular size was greatly reduced and when other factors—the brightness of the background, the proximity of other coloured objects, the pupil size, etc.—were modified.

While some of the results will be familiar to readers of Helmholtz ("Physiologische Optik", 2, 128 and 239–41, 3rd Edit.), many new observations are reported, and it is shown how they fit in with the apparent absence of fringes in ordinary vision. After skittling down a number of alternative hypotheses, Prof. Hartridge puts forward his own explanation of the changes in apparent colour. His 'neurological hypothesis' postulates four nervous mechanisms (antichromatic responses) which operate locally in all parts of the fovea and parafovea and the function of which is to control the connexion between photo-receptors and cranial centres. Thus the connexion between medium-wave receptors and the cranial centre for short waves is controlled by the 'yellow' mechanism, that between short-wave receptors and their cranial centre by the 'blue' mechanism. The mechanisms may also act together: the 'red' and 'green' mechanisms acting together change colourless vision to reduced (so-called diochromatic) vision, and 'yellow' and 'blue' mechanisms acting together then alter the latter to full colour vision. The neurological hypothesis is not a simple one, and without the answers to several questions, which Prof. Hartridge does not provide, it is difficult to form even a crude picture of the way the mechanisms work. It is not clear, for example, whether they have end-organs of their own or whether they must receive nervous stimuli from the photo-receptors which they are connecting or disconnecting with the cranial centres. More specific assumptions would seem necessary if any quantitative development of the hypothesis is to be possible.

To answer another main question, namely, the reason why at high intensities visual acuity depends so little on the colour of the light, Prof. Hartridge suggests that retinal receptors of each particular type (spectral response) tend to be collected in small clusters. Thus to see fine detail in blue light, the retinal image is brought on to a cluster of 'blue' receptors; but if red light is used, there is a slight change of fixation to bring a cluster of 'red' receptors into action. Several experiments were made showing that slight changes in the direction of fixation for lights of different colours do occur. These changes in fixation, together with the changes observed in the apparent colour of very small test stimuli, are also regarded by Prof. Hartridge as strong evidence for the existence in the human retina of some seven types of receptor with narrow spectral sensitivity curves analogous to the modulator curves obtained in Granit's electrophysiological studies on animals (polychromatic theory of human vision).

One difficulty with this paper is that Prof. Hartridge has not only lost faith in the trichromatic theory, but he has also, it seems, abandoned the whole mode of approach through colour-matching measurements by which the purely empirical structure of the theory has been built up. One feels that the new ideas, if valid, must interlock with this empirical structure; but Prof. Hartridge does not show that they do.

W. S. Stiles

FRUIT AND VEGETABLE CULTURE

THE annual report for 1945 of the Agricultural and Horticultural Research Station at Long Ashton, Bristol, gives results of the Station's work on the scientific horticulture of fruit and vegetable crops and on their products.

Classification of the visual symptoms of mineral deficiencies of crop plants is continued by E. J. Hewitt. He uses various refinements in technique, including a 'Permutit' demineralization method of purifying rain-water for studies of iron deficiency, and a method for transplanting adult plants without root disturbance. The present survey embraces deficiencies of twenty-nine crops grown in sand culture, and one incidental result is that a high nitrogen-level accentuates the symptom expressive of boron deficiency. Some of the effects of soil acidity on crops are not yet fully understood, and Hewitt also has a progress report on this matter. It would seem that some at least of the symptoms of acid damage are those of manganese toxicity, and other interesting tentative conclusions are mentioned. D. J. D. Nicholas has investigated the validity of rapid chemical tests for the diagnosis of mineral deficiencies in potato plants. He finds a welcome accord with the results of the full chemical analysis, and with the visual symptoms. Several useful correlations between deficiencies and toxicities are established. Spraying the foliage of tomato crops with 2 per cent magnesium sulphate solution is found to be a much better control of magnesium deficiency than soil applications of the same substance, according to D. J. D. Nicholas, J. O. Jones and T. Wallace. The director of the Station, Prof. T. Wallace, with E. Catlow, gives two extensive reports on the manuring of potatoes and garden beet respectively.

A useful classification of power-operated hydraulic spraying machinery for fruit crops has been prepared by H. G. H. Kearns. He gives broad specifications for the chief components of spray outfits, and estimates the biological requirements of spraying. Growers should find this paper a useful practical guide to the choice of this section of equipment. The advent of D.D.T. and benzene hexachloride makes it necessary to find the best methods of incorporating these sprays in a comprehensive programme. H. G. H. Kearns, R. W. Marsh and H. Martin have made experiments on this problem, which rather suggest that D.D.T. is an excellent insecticide against certain pests, but offers no widespread panacea of control. It was effective against leaf-curling aphids. Comparisons of three fungicides—tetramethylthiuram, ferric dimethyldithio-carbamate, and copper sebacate—were also included. The last-mentioned was approximately equal to lime sulphur as a fungicide. Other papers in this section deal with the flight period of the codling moth in relation to time of spraying (S. H. Bennett), the effect of early lifting and other factors on storage losses of onions (H. E. Croxall), attack of lettuce by two strains of the fungus *Bremia lactucæ*, and the relation of the disease to wild species of *Lactuca* (L. Ogilvie), and clover-rot investigations by Moira Munro and L. Ogilvie. The general features of eelworm attacks of vegetable crops are reviewed by H. W. Miles and Mary Miles, and A. J. Lloyd briefly outlines results of a biological method of estimating the intensity of clover stem eelworm infections in field soils. A short paper by May J. Haddock shows that the 'turnip flea beetle' is not a single species, but a complex of as many as eight species. They all seem to have a wide taste for cruciferous plants; but this numerical expansion of species does not seem to offer any change in methods of control.

The Station has also investigated problems relating to fruit and vegetable products. Workers in this field will find papers on the control of blackening of boiled potatoes, factors affecting quality in potatoes and tomatoes, the apple as a source of vitamin C, and the Station's major cider research.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Laboratory Assistant (Grade II) in the Department of Chemistry—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (December 29).

Veterinary Inspectors in the Ministry of Agriculture for Northern Ireland—The Secretary, Civil Service Commission, Stormont, Belfast (December 31).

Assistant Chemist in the Chiswick Laboratory—The Staff Officer (ER/E. 457), London Passenger Transport Board, 55 Broadway, London, S.W.1 (December 31).

Senior Lecturer, and a Reader, in Agriculture, at Makerere College, East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (December 31).

Qualified Chemists in the Generating Stations at Chelsea and Neasden—The Staff Officer (ER/E. 454), London Passenger Transport Board, 55 Broadway, London, S.W.1 (December 31).

Bacteriologist to take charge of a public health laboratory service in Belfast—The Establishment Officer, Ministry of Health and Local Government, Stormont, Belfast (December 31).

Research Fellow to work on the problem of origin and measurement of stresses in cast metal products—The Professor of Industrial Metallurgy, The University, Edgbaston, Birmingham 15 (December 31).

Demonstrator (part-time) in the Pharmacology Department—The Dean, Guy's Hospital Medical School, London, S.E.1 (December 31).

Lecturer in Anatomy at Makerere College, East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (January 1).

Lecturers (2, Grade IIc or IIb) in Chemical Engineering—The Secretary, The University, Edmund Street, Birmingham (January 1).

Lecturer (Grade IIc) in Pharmacology—The Secretary, The University, Edmund Street, Birmingham 3 (January 8).

Scientific Officer in the Blood Transfusion Laboratories, Manchester—The Regional Transfusion Officer, Royal Infirmary, Manchester 13 (January 10).

Lecturer (Grade IIc) in Electrical Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (January 10).

Senior Scientific Officer or Scientific Officer (Ref. No. A.337/47), and a Senior Experimental Officer or Experimental Officer (Ref. No. F.773/47), at the Atomic Energy Research Establishment, Harwell, Didcot, Berks—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (January 10).

Director of a new Vegetable Research Station—The Chairman. Organising Committee, Vegetable Research Station, Ministry of Agriculture, Block 4, Bickenhall Mansions, Baker Street, London, W.1 (January 24).

DEPUTY CHIEF FUEL ENGINEER, London (male)—The Director of Establishments, Ministry of Fuel and Power, 7 Millbank, London, S.W.1, quoting 'Deputy Chief Fuel Engineer' (January 29).

PRINCIPAL MEDICAL OFFICER (Research), MEDICAL OFFICERS (Research, 3), a PRINCIPAL SCIENTIFIC OFFICER, SENIOR SCIENTIFIC OFFICERS (4), and EXPERIMENTAL OFFICERS (6), in the Chemical Defence Experimental Station, Porton, Wilts—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2075 (January 29).

CHANDOS PROFESSOR OF PHYSIOLOGY in the United College—The Secretary, The University, St. Andrews (February 28).

LECTURER IN STATISTICS—The Registrar, Trinity College, Dublin (March 1).

CHAIR OF GEOGRAPHY—The Registrar, University College, Exeter.

DEMONSTRATORS (2) IN THE DEPARTMENT OF BIOCHEMISTRY AND CHEMISTRY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

PLANT PATHOLOGIST for the East African Groundnut Scheme—The Personnel Manager (Technical), United Africa Co. (Managing Agency), Ltd., Unilever House, London, E.C.4.

HEAD LABORATORY TECHNICIAN, Grade A (organic or medical chemistry)—The Director, Wellcome Laboratory of Human Nutrition, Churchill Hospital, Oxford.

TECHNICIAN IN THE DEPARTMENT OF PHYSICS—The Secretary, University College London, Gower Street, London, W.C.1, quoting Physics/1.

PHYSICIST, PHYSICAL CHEMISTS (2), an ORGANIC CHEMIST, and a TEXTILE TECHNOLOGIST—The Acting Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1.

ASSISTANT PUBLICATIONS OFFICER to deal with the editing, publication and distribution of research reports—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

METALLURGIST FOR THE LIAISON AND TECHNICAL SERVICE DEPARTMENT, and an INVESTIGATOR IN THE ANALYTICAL DEPARTMENT—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Imperial Bureau of Animal Breeding and Genetics, Edinburgh. Technical Communication No. 5: Gestation Periods; a Table and Bibliography. Compiled by Dr. J. H. Kenneth. Second edition. Pp. 30. (Aberystwyth: Imperial Agricultural Bureaux, 1947.) 3*s*. [94

Manchester Joint Research Council. Communication Series No. 2: Report of Conference on Research and the Smaller Firm, held on Wednesday, 16th October 1946, at the Albert Hall, Manchester. Pp. 102. (Manchester: Manchester Chamber of Commerce, 1947.) 2*s*. 6*d*. [94

The Road Back to Health: the Story of Medical Rehabilitation. (Published for the Ministry of Health.) Pp. 28. (London: H.M. Stationery Office, 1947.) 6*d*. net. [94

Forestry Commission. Bulletin No. 13: Studies on Tree Roots. Reprint. Pp. 72 + 17 plates. (London: H.M. Stationery Office, 1947.) 3*s*. 6*d*. net. [94

Ministry of Fuel and Power: Safety in Mines Research Board. Paper No. 105: The Prevention of Coal Dust Explosions, Part 1: The Effect of Manner of Distribution of Stone Dust. By S. Jones and F. V. Tideswell. Pp. 24. (London: H.M. Stationery Office, 1947.) 6*d*. net. [154

Federation of British Industries. Industrial Research in Technical Colleges. Report of a Special Sub-Committee of the F.B.I. Industrial Research Committee. Pp. 22. (London: Federation of British Industries, 1947.) [154

Watford Industrial Exhibition. Opened on 5th June 1947 by the Rt. Hon. Lord Brabazon of Tara and continuing until 18th June. Pp. 60. (Watford: Town Hall, 1947.) [154

The Life and Work of George Gerald Henderson. By Prof. Sir Ian Heilbron. (First Henderson Memorial Lecture.) Pp. 12. (London: Royal Institute of Chemistry, 1947.) [154

The History and Prevention of Silicosis, with Special Reference to the Witwatersrand. By Dr. A. J. Orenstein. (First Sir Julius Wernher Memorial Lecture.) Pp. 19. (London: Institution of Mining and Metallurgy, 1947.) [154

Reports of the Council and Auditors of the Zoological Society of London for the Year 1946. Pp. 40. (London: Zoological Society of London, 1947.) [174

Department of Scientific and Industrial Research: Standing Consultative Conference on Fuel Research. Fuel Abstracts. New Series, Vol. 1, No. 1, January: Abstracts Nos. 1 to 522 and Subject Index. Pp. ii + 128 + xvi. (London: H.M. Stationery Office, 1947.) 50*s*. per annum. [174

British Electrical and Allied Manufacturers' Association. Report of the Council for the Year 1946–47. Pp. 32. (London: British Electrical and Allied Manufacturers' Association, 1947.) [174

John Innes Horticultural Institution, Merton and Hertford. Thirty-seventh Annual Report, 1946. Pp. 32. (London: John Innes Horticultural Institution, 1947.) [174

Further Education: a Monthly Review of Planning and Progress. Vol. 1, No. 1, April. Pp. 24. (London: Turnstile Press, Ltd., 1947.) 1*s*. 6*d*. net. [224

Other Countries

Carnegie Institution of Washington. Publication 551: Contributions to Paleontology—Fossil Vertebrates from Western North America and Mexico. By E. L. Furlong, E. Raymond Hull, Lore Rose David, Robert E. Wallace and Hildegarde Howard. Pp. iii + 195 + 31 plates. (Washington, D.C.: Carnegie Institution, 1946.) 2.50 dollars. [313

Smithsonian Institution: United States National Museum. Bulletin 191: Life Histories of North American Jays, Crows and Titmice, Order Passeriformes. By Arthur Cleveland Bent. Pp. xi + 495 + 68 plates. (Washington, D.C.: Government Printing Office, 1946.) [313

A Five Year Plan for the Geological Survey of India: Memorandum on the Expansion and Reorganisation of the Geological Survey of India. Pp. ii + 25. (Calcutta: Government of India Press, 1946.) [313

Ministry of Public Works, Egypt: Physical Department. Paper No. 51: The Nile Basin. By Dr. H. E. Hurst, R. P. Black and Y. M. Simaika. Vol. 7: The Future Conservation of the Nile. Pp. xv + 178 + 27 plates. (Cairo: S.O.P. Press, 1946.) P.T. 125; 25*s*. [313

Report of His Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the Year 1942. Pp. 6. Report of His Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the Year 1943. Pp. 7. Report of His Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the Year 1944. Pp. 8. (Cape of Good Hope: Royal Observatory, 1943–1945.) [94

Smithsonian Miscellaneous Collections. Vol. 106, No. 22: Solar Cycles. By H. H. Clayton. (Publication 3870.) Pp. ii + 18. (Washington, D.C.: Smithsonian Institution, 1947.) [94

State of California Department of Natural Resources: Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 65: Analysis of Populations of the Pacific Sardine on the Basis of Vertebral Counts. By Frances N. Clark. Pp. 26. (Terminal Island, Calif.: Department of Natural Resources, 1947.) [94

Carnegie Institution of Washington. Year Book No. 45, July 1, 1945—June 30, 1946, with Administrative Reports through December 13, 1946. Pp. xxxiv + 235. (Washington, D.C.: Carnegie Institution, 1946.) [94

Canada: Department of Mines and Resources: Mines and Geology Branch, Bureau of Mines. No. 817: Peat Moss Deposits in Canada. By Harald A. Leverin. Pp. v + 102 (9 plates). (Ottawa: King's Printer, 1946.) 25 cents. [94

Government of Cyprus. The Proceedings of a Conference on Land Use in a Mediterranean Environment, held in Nicosia, Cyprus, 16th–17th April, 1946. Pp. 55. 7*s*. Report of the Land Utilization Committee, 1946. Pp. 32. 5*s*. (Nicosia: Government Printing Office, 1946–1947.) [94

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 167: The Detonation of Nitroglycerine by Impact. By Dr. F. P. Rowden, Dr. F. Eirich, A. E. Ferguson and A. Yoffe. Pp. 44 + 8 plates. Bulletin No. 173: The Detonation of High Explosives by Impact; The Sensitivity, and the Propagation of the Explosion in Liquids. By Dr. F. P. Rowden, Dr. R. Eirich, M. F. R. Mulcahy, R. G. Vines and A. Yoffe. Pp. 75 + 34 plates. Bulletin No. 195: An Account of Experiments undertaken to Determine the Natural Population Density of the Sheep Blowfly, *Lucilia cuprina* Wied. By Darcy Gilmour, D. F. Waterhouse and G. A. McIntyre. Pp. 39 + 3 plates. Bulletin No. 196: Transmission of Potato Virus Diseases, 5, Aphid Populations, Resistance and Tolerance of Potato Varieties to Leaf Roll. By Dr. J. G. Bald, D. O. Norris and G. A. H. Helson. Pp. 32. Bulletin No. 199: The Use of Mineral Dusts for the Control of Wheat Pests. By Frank Wilson. Pp. 31 + 1 plate. (Melbourne: Government Printer, 1943–1946.) [154

Trinidad and Tobago. Empire Forests and the War. Pp. 16. (Trinidad: Government Printer, 1947.) 48 cents. [154

Institut de France: Académie des Sciences. Annuaire pour 1947. Pp. 230. (Paris: Libr. Gauthier-Villars, 1947.) [174

Forest Research in India and Burma, 1944–45. Part 1: The Forest Research Institute. Pp. iii + 149. (Dehra Dun: Forest Research Institute, 1946.) 3.8 rupees; 5*s*. 6*d*. [174

N.B.C.'s Air Castles. Pp. 52. (New York: National Broadcasting Co., Inc., 1947.) [174

Fieldiana: Geology. Vol. 10, No. 4: A New Pycnodont Fish from the Cretaceous of Arkansas. By Louis Hussakof. Pp. 23–28. (Chicago: Chicago Natural History Museum, 1947.) 10 cents. [174

Fieldiana: Zoology. Vol. 31, No. 9: Notes on Amphibians and Reptiles of Michoacan, Mexico. By Karl P. Schmidt and Frederick A. Shannon. Pp. 63–86. 25 cents. Vol. 31, No. 10: Two Races of the Bridled Titmouse. By A. J. van Rossem. Pp. 87–92. 10 cents. Vol. 31, No. 11: A New Race of Koklas Pheasant. By Robert L. Fleming. Pp. 93–96. 10 cents. (Chicago: Chicago Natural History Museum, 1947.) [174

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 198: Plant Responses to Molybdenum as a Fertilizer. 1: Molybdenum and Symbiotic Nitrogen Fixation, by A. J. Anderson and Margaret P. Thomas; 2: Factors Affecting the Response of Plants to Molybdenum, by A. J. Anderson and A. C. Oertel. Pp. 44 + 7 plates. (Melbourne: Government Printer, 1946.) [174

Sixty-third Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1945–1946. Pp. 12. (Washington, D.C.: Government Printing Office, 1947.) [174

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Papers in Physical Oceanography and Meteorology published by Massachusetts Institute of Technology and Woods Hole Oceanographic Institution. Vol. 10, No. 1: Measurements of Temperature and Humidity in the Lowest 1000 Feet of the Atmosphere over Massachusetts Bay. By Richard A. Craig. (Contribution No. 362 from the Woods Hole Oceanographic Institution.) Pp. 48. (Woods Hole, Mass.: Woods Hole Oceanographic Institution, 1946.) 75 cents. [174

Annual Report of the Queen Victoria Museum and Art Gallery, 1945–1946. Pp. 6. (Launceston: Queen Victoria Museum and Art Gallery, 1946.) [75

Queensland Institute of Medical Research. First Annual Report, Year ended 30th June 1946. Pp. 8. (Brisbane: Queensland Institute of Medical Research, 1946.) [75

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ORGANISATION FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

SIR EDWARD APPLETON, in his A. D. Little Memorial Lecture in 1946, distinguished three types of research: free fundamental research, prosecuted in universities and similar institutions, without any regard to immediate or future application; objective fundamental research, designed to give insight and understanding rather than any special immediate practical result; and, third, applied research. He emphasized that there is no sharp differentiation between these types of research, but he finds them a more convenient classification than the older division into 'pure' and 'applied' research. The second type is carried out, as well as applied research, in Government establishments; some will also be carried out in industrial research laboratories, although in the main the latter will be carrying out applied research.

Now there are two points here of special importance in regard to the research associations which have led to doubts as to whether their expansion is wise without further inquiry and some experiment with institutions of the type of the Mellon Institute or the Institute of Paper Chemistry at Appleton, Wisconsin. As the Advisory Committee of the Privy Council noted in its first report in 1916, and as Dr. D. W. Hill points out in his recent book, a research association that fails to encourage and to inspire research activity on the part of its members fails in a vital part of its function. The research activities of the research associations may even be of secondary importance to the stimulus they give to independent research, and in assessing the value of the whole movement it is of prime importance to recognize the extent to which research has been stimulated in industry itself through their work. It is far more important to ensure that the contact and general relations between the research associations and industry, geographically and in other ways, are such as to ensure that there is the maximum interchange of information, ideas and inspiration, and that co-operation is real and not nominal, masked by payment of a subscription.

It is true that recent fiscal changes introduced by the Government may stimulate research by private firms in future, although for the moment the concession as regards capital expenditure may be largely ineffective; but it is the more important to direct attention to these questions first rather than to the selection of problems for immediate conjoint research, because of the trend in so many reports from the 'working parties' of the Board of Trade to advocate a compulsory levy for research. There is real danger that even a voluntary subscription to a research association may act as a sedative and induce a reluctant firm to think that it has done all that is necessary, and take no further steps to ensure that it is staffed and equipped to utilize the results of research as they are made available.

More effective liaison work may do something to decrease the danger, and hence the growing importance of the work of the information departments maintained by the individual research associations and centrally by the Department of Scientific and Industrial Research. Compulsory contributions are, however, likely to increase the danger, and for this reason alone experiment with the alternative type of organisation, the research foundation, might well be worth while.

That idea has received strong support in recent conferences; the Fulmer Research Institute, opened last July, is one of the first steps taken to fill a recognized gap in the organisation of research in Great Britain, and in welcoming this initiative, Sir Stafford Cripps, then President of the Board of Trade, expressed the hope that the Institute would be the forerunner of others on similar lines which might largely fill the gap altogether. At the Scottish Regional Conference of the Federation of British Industries in Glasgow last April, Prof. R. Hay suggested the establishment of a foundation for Scotland on Mellon Institute lines, and in view of Sir Edward Appleton's remarks at the Manchester Conference on "Research and the Smaller Firm", it would appear that concrete Government support may be forthcoming for particular proposals of that kind. While the organisation of research in Great Britain is still fluid, every opportunity should be utilized of making such experiments before too heavy a proportion of the nation's resources for research are committed to particular forms that may prove to be not the most desirable.

The importance of research organisation is well brought out in a recent survey of German research institutions by Col. L. E. Simon*. According to Col. Simon, German war research was defective in three respects. It failed to plan basic research with appropriate anticipation of future requirements for development—much time was wasted on stop-gap measures; it did not provide an adequate development echelon which was independent of self-interest; and intelligent communication between research units and the German army was lacking. For such reasons, in spite of the quality of much of their basic and technical research and the excellence of design, German research on war weapons was markedly inferior to that of Britain or the United States. Defective leadership and absence of effective means for technical co-ordination, coupled with poor development, in Col. Simon's view, probably reduced the effectiveness of German research and development by fifty to ninety per cent.

That verdict alone invites a closer scrutiny of the structure developed in Great Britain for war purposes, and particularly of what is usually described as 'operational research', with the view of seeing whether any features of the latter should be incorporated in our peace-time system. Before doing so, Col. Simon's observations on the institute as the fundamental unit in the organisation of research are worth noting. In view of the proposals made in Britain for development on such lines, it is of interest that Col. Simon commends the idea for trial in American industry, and he outlines with some care the factors to which its success in Germany is attributed. The institute should not be larger than one man can administer effectively through group leaders only one echelon above the research workers themselves, and in practice this means a staff not exceeding three hundred in all. The leader in an institute of this size should not tend to become an administrator instead of a scientific leader. Obviously, there are other questions of organisation, such as the relation of the institute to other research units and to industry, the universities or departments of State; but Col. Simon seems to think that such a unit has inherent possibilities of avoiding the danger which Sir Henry Dale emphasized and to which Mr. John Mills, lately director of publications at the Bell Telephone Laboratories, also directed attention in his recent book, "The Engineer in Society", that of diverting our ablest scientific minds from the creative work of research into administrative work which could be done by others less fertile and imaginative, even if they too require some appreciation of the scientific attitude.

For the rest, what Col. Simon notes about the conditions most conducive to creative research confirms what was emphasized in the Barlow Report on Scientific Staff and in other reports which have appeared in Britain and in the United States during recent years. To most of these considerations Government, the universities and industry now appear to be fully alive, and it is to be hoped that restrictions imposed by the economic crisis will not be allowed to endanger the situation. There is, in fact, at least some reason for concern at the apparent lack of appreciation on the part of the Government as to the importance of incentives for research workers, even if the threat is indirect rather than direct. Many of the general restrictions already imposed from quite other considerations have a detrimental effect on efficiency which, by engendering a feeling of frustration, tends to undermine incentives and destroy the atmosphere in which creative work is most fruitfully pursued.

One other factor noted by Col. Simon may also be mentioned—that of scientific intercourse and the exchange of ideas—and this stresses the value of the new intelligence group of the Department of Scientific and Industrial Research, some of the research stations of which may well be regarded as research units of the type mentioned above. Into the same category would fall a number of the research associations, such as the British Cotton Industry Research Association, which maintain a central institution; but we are here concerned with a factor which does not appear in Col. Simon's analysis. The units he describes are occupied essentially on fundamental research or the search for new knowledge of a broad or general character, and only to a lesser extent with technical or engineering research as he terms it.

The comments in the third report of the Select Committee on Estimates as well as the establishment of the Advisory Council on Scientific Policy warrant a hope that an inquiry will be held into the possible types of organisation for co-operative industrial research.

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* German Research in World War II: an Analysis of the Conduct of Research. By Colonel Leslie E. Simon. Pp. x+218. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 24s. net.

There is a further matter relating to the expansion of the research association movement which requires consideration. A number of the research associations have already recognized that the utilization of the results of research by an industry depends on the presence within the industry of men able to appreciate the significance of these results and to apply them in practice. That has been repeatedly stressed in reports from the 'working parties'. The most effective way of strengthening an industry is by the recruitment of young men of wide educational background and of a scientific attitude of mind. The 'working party' for the lace industry in its recent report gave close attention to this question of recruitment and training, and pointed out that the presence of such men in the industry would assist it to make the best use of the results of research and also help to render fruitful the investigations carried out by individual firms.

No attempt was made in this report to indicate how such recruits should be introduced to the lace industry, and one aspect of the research association movement or the research institute which needs to be studied more closely is its success in supplying industry with men with a scientific training and research outlook, and in securing the interchange of staff. This, with such an industry as the lace industry, is just as important as securing close contact of the association or institute with the industry it primarily serves; one important factor in the success of the Institute of Paper Chemistry at Appleton, Wisconsin, is probably its location in a compact area of paper mills and paper-mill machinery manufacturers, and its association with Lawrence College, so that teaching and research are associated as in a university. Once this problem of the introduction to the industry, particularly at the managerial and administrative level, of men of a scientific outlook, qualified and competent to appreciate the contribution of science, is overcome, there will be little difficulty in formulating appropriate programmes or targets for research. But unless it is done, and the industry becomes thus qualified to interpret and apply, and even in some degree to direct research, there appears to be real danger that the measures contemplated by the lace industry 'working party' in regard to research and development may have only a passing effect, and fail to produce the sustained effort and the change of outlook that are imperative.

We have to remember that the traffic between science and industry must be in both directions, and the research association or the research institute, like the research department of an individual firm or of a Government department, must look not only to the manufacturing department or works, but also to the universities and other centres where the frontiers of knowledge are being continually advanced. The importance of this has indeed been strongly impressed on us by our war-time experience. Sir Edward Appleton referred in his lecture to the brilliant success of university men of science in solving war problems entirely remote from their peace-time interests, and to the way in which university conditions generally favoured the maintenance of the mental adventurousness and lively imagination so necessary for scientific progress. Possibly the regional research council might make an important contribution here.

The Interdepartmental Scientific Panel is clearly seeking to ensure that conditions in the future Scientific Civil Service of Britain encourage these same qualities, but in the meantime the brilliant success which has attended the close collaboration between scientific worker and Service man already noted has led to the suggestion that the same type of collaboration should be organised for the attack on peace-time objectives. The value of close collaboration between producer and user has long been recognized in some sections of industry, as is evident in the technical service to customers maintained by numerous progressive firms. In this dual flow of ideas there is a continuous improvement in the products of industry; and the value of contact between user and investigator and of all concerned in a research problem could scarcely be better put than by Dr. Price Russell in his lecture "The Organisation of Industrial Research" before the Industrial Research Committee of the Federation of British Industries.

The similarity between this and the basic idea behind 'operational research' is obvious, and Sir Robert Watson-Watt has made the pertinent remark that operational research is beginning to look very like real scientific management. Leaving for the moment the possible contribution 'operational research' may make to the still unsolved problem of the relationship between the administrator and the expert, and confining ourselves to the scientific and technical level, there should be noted the value, established in our war-time medical research, of a section composed of independent, full-time and fully mobile observers; and the conclusion that minority opinions should not be ignored even when counter to expected results. To both of these points Prof. W. C. Wilson has directed attention; but much careful thought will be required as to the means by which the first feature, which has something in common with the nuclear group described by Sir Percy Dunsheath, can be incorporated in our existing organisation.

In the main, however, those who, like Prof. J. D. Bernal, are anxious to see the technique of 'operational research' adopted in our peace-time structure, are thinking of doing so at a higher level, and with the view of seeing that Great Britain's limited resources in engineering and science are used in the most effective way possible, having regard not merely to the existing situation, but also to the way in which resources could be very considerably and rapidly increased. To some extent that is a matter of providing what Dr. R. P. Russell termed the political climate of research; but apart from what could be done at that level, it rests largely with scientific workers themselves to ensure that so far as organisation is concerned the channels of communication are adequate and effective, and that there is a free flow of workers and ideas between the universities, industry and the departments of State. New departures, such as the diversion suggested by Dr. Wansbrough-

Jones of young scientific men really interested in the social applications of science for a short time to 'operational research', may well assist. With adequate safeguards it might be an advantage to many to work for a year or so, say in their late twenties, for a Government department; to leave industrial laboratories to work on the scientific man-power side of their industries, and defence laboratories to work with the Services.

These are all tactical measures designed to increase mobility and, by facilitating the interchange of staff and ideas, to foster that cross-fertilization of minds which is so fruitful of real scientific advance. If such measures are to succeed, however, they must secure the cordial support and the careful and unceasing criticism of men of science themselves, individually and through their professional associations. They must be quick to note and to make representations against any developments which, by over-organising science, or, for example, hindering the vital freedom of the investigator to single out the right path to his objective in the complex situation existing on the frontier of knowledge, and to resist encroachment from the administrative side as to the methods to be adopted and/or the particular paths to be followed in the search for solutions of scientific problems. In his presidential address to the Royal Society Sir Robert Robinson indicated that this particular danger is now very slight. Even the selection of problems for investigation cannot be made wisely without the participation of the scientific investigator himself; and the most disturbing features in both Sir Edward Appleton's lecture and the report of the Select Committee on Estimates are the indications that in some departments of State all is not well in this respect, and that there is still failure to identify departmental problems suitable for scientific treatment, to see that these problems are passed to the appropriate research bodies for handling, and to interpret the incoming scientific material for the special departmental purposes.

It may be the function of the Advisory Committee on Scientific Policy to remedy defects in departmental organisation in due time; but no matter how efficient the organisation for research which is ultimately developed for the nation's purposes, in the sphere of Government itself, in the universities or in industry, no matter how well balanced the distribution of man-power between the different fields, or adequate the financial endowments and other material resources, the benefits the nation derives will depend ultimately both on the quality of the men of science engaged in the research and of those who, whether or not they are themselves men of science, are responsible for the administration. It is appropriate that at this present time the whole organisation and expenditure of the nation on research and development should be subject to the closest scrutiny, that the impact of restrictions on capital development should be examined, and that the possibilities of new types of organisation for research and new techniques for co-operation should be explored. There can be no more finality in the organisation than in the results of research.

MATHEMATICS OR PHYSICS?

Conduction of Heat in Solids

By Prof. H. S. Carslaw and J. C. Jaeger. Pp. viii+386. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 30s. net.

CARSLAW and Jaeger have produced an interesting book, different parts of which will meet the needs of mathematical physicists, experimental physicists, university teachers and design engineers. It is didactic rather than exploratory. In plan it owes much to Carslaw's "Introduction to the Mathematical Theory of the Conduction of Heat in Solids" which appeared in 1921; but the volume now under review differs so much from the earlier one that it must be considered as a new work rather than a revised version of the older one. It embodies many advances that have been made during the past twenty-five years, as can be seen from the numerous references to mathematical, physical and engineering publications, many of which have been published since 1921. The references also indicate that while attempting to give the book a pronounced mathematical flavour, the authors have also tried to make it useful to engineers and physicists. In addition, some essentially 'practical' topics are treated briefly in the text; of these some of the more interesting ones are: cooling fins, the conduction of heat in a thin wire heated by an electric current, automatic temperature control, heat regenerators and heat exchangers, the heating of a chain of radiating slabs, etc. No attempt has been made to treat these topics in great detail, but references are given to the relevant further literature.

The preparation of the book must have presented the authors with almost all the types of problem confronting those who write on branches of physics that lend themselves to detailed mathematical treatment. Should the subject be treated as a physical one, and the mathematical techniques of solution relegated to appendixes or to sections in smaller type? Should there be a discussion of fundamental principles, or should it be assumed that readers will be familiar with them? Should the book be written for research workers, or for teachers and students? There is no doubt that the authors were aware of these questions and that they decided to assume that the basic physical ideas were well known. Problems were grouped and discussed according to the mathematical techniques employed in solving them. For example, after an introductory chapter (1) dealing with the derivation of the equation of the conduction of heat, the appropriate general theory, boundary conditions, uniqueness of solutions, etc., there follows a sequence of chapters (2–9) in which are grouped problems that involve the flow of heat in an infinite and semi-infinite solid (2), solids bounded by two parallel planes (3), in a rod (4), in a rectangle (5), etc.

At this stage, the mathematical technique of the Laplace transform is introduced (11). This chapter contains an outline of the history of the development of the transform, of its fundamental mathematical properties, and of its application to problems involving the linear flow of heat. The remaining chapters (12–15) deal primarily with the application of the transform to problems more complicated than those discussed earlier in the book. The authors point out that the Laplace transform could have been introduced earlier in the text, and that such an early introduction would have simplified much of the previous chapters. They felt, however, that the juxtaposition of the classical technique and the more modern one should be very helpful, and the reviewer agrees with them wholeheartedly. Six valuable appendixes conclude the text.

The book would have been more satisfying had more space been devoted to brief critical accounts of physical principles and definitions. For example, the orders of magnitude of the variation of conductivity and specific heat with temperature might have been discussed and, where known, the results of taking these variations into account might have been compared with the result of assuming these quantities to be constants. Or again, the note on the effect of turbulence on the coefficient of outer conductivity might have been amplified.

The authors have written on a difficult subject. They have formulated their plan with care and have kept to it. Others, including the reviewer, might have preferred a more physical approach without the sacrifice of any of the mathematical ingredients of the publication, but this is purely a matter of opinion. Carslaw and Jaeger are to be congratulated upon this addition to the literature of the conduction of heat in solids, and note should be taken of the compliment paid by Prof. Carslaw to his junior colleague, Dr. Jaeger, when he says in the preface "He is most certainly its principal author".

This review would not be complete without a special note of praise for the printing and binding. Those whose work involves a close scrutiny of scientific texts are indebted to the Oxford University Press for the continuation of its high standards even in times of great difficulty. L. ROSENHEAD

THE NEUROTIC PERSONALITY

Dimensions of Personality

By Dr. H. J. Eysenck. A Record of Research carried out in collaboration with Dr. H. T. Himmelweit, Dr. W. Linford Rees, and with the help of Dr. M. Desai, W. D. Furneaux, H. Halstead, Dr. O. Marum, M. McKinlay, A. Petrie and P. M. Yap. Pp. xi + 308. (London: Kegan Paul and Co., Ltd., 1947.) 25*s*. net.

THIS book is based upon research carried out by a team of psychologists working at the Mill Hill War Emergency Hospital. The object of their investigations was to discover the relationship of various traits of personality to 'neuroticism'. The experiments were performed on a group of patients, numbering seven hundred, suffering from reactive types of mental illness. The statistical method was used, and careful correlations are given for the various traits.

The authors state that two main facts emerge from their study. First, there is a general factor, 'neuroticism', shown by signs of a badly organised personality, poor muscular tone, pre-service evidence of abnormality, abnormal parents and unsatisfactory home-life. Secondly, a bipolar factor with affective type of symptoms (anxiety, depression, obsessional tendencies, etc.) at one end and hysterical type (conversion symptoms, sex anomalies, low intelligence, bad work history, hypochrondriasis, etc.) at the other.

A number of studies were made upon physique and constitution, such as body build, autonomic activity, dark vision, choline esterase secretion and exercise response. The authors claim significant differences between the two groups. Other studies were made upon neurotics and non-neurotics with regard to intelligence, accuracy of work, level of aspiration and so on. These tests are claimed to differentiate dysthymics from hysterics and normals from neurotics.

Tests were also made upon various types of suggestibility and the relation of them to hysteria. The authors believe that there is no evidence that hysterics are more suggestible than other neurotics. They found, however, that suggestible patients were made more so by narcotics, whereas non-suggestible ones remained unaffected. In the experiments made upon appreciation and expression it was found that neurotics were more reactive to colour, but there was no difference between the hysteric and the dysthymic.

These tests may arouse some readers to complain that the mind is so fractionated in such a study that nothing much is proved. Prof. Aubrey Lewis, in the brief foreword, answers this objection that the methods are 'atomistic', and points out that it is an attempt at "the analysis, by reliable statistical techniques, of experimental and clinical data, so that measurement may be possible and a sight obtained of the promised land where mental organisation will be as well understood as the physical organisation of human beings is".

This research is interesting, and the frequent quotations show a wide knowledge of the literature. A few show an unnecessary desire to quote from other Maudsley colleagues, as, for example, that on page 51: "A person's constitution may render him liable to breakdown at the slightest provocation; on the other hand, a person of first-class constitution may finally break down when the stress is too great." This is such a psychiatric commonplace that surely it has been stated many times before Slater in 1944. These, however, are minor blemishes and the book as a whole is valuable.

The format is neat, the paper good and the printing clear. It is written as easily as such a subject allows. There is a useful summary of the findings at the end of each chapter and many diagrams clarify the text. There is a long bibliography of 24 pages and an excellent index. CLIFFORD ALLEN

"CUSHNY'S PHARMACOLOGY"

Pharmacology and Therapeutics

Originally written by Prof. Arthur R. Cushny. Thirteenth edition, thoroughly revised by Prof. Arthur Grollman and Dr. Donald Slaughter. Pp. 868. (London: J. and A. Churchill, Ltd., 1947.) 45*s*.

WHEN Cushny's text-book first appeared in 1899, it was recognized as being "the first severely critical, rigorously scientific general text-book to be written in English by an experimental pharmacologist". It helped to put the science of pharmacology on secure foundations by eliminating traditional lore and concentrating attention on proved facts. It became the standard text-book in English on both sides of the Atlantic, and Cushny himself was responsible for eight editions. After his death in 1926, four more editions were prepared jointly by Prof. J. A. Gunn of the University of Oxford and Prof. C. W. Edmunds of the University of Michigan. The thirteenth edition, which has recently appeared, is a purely American production. Most of the work of revision has been done by Prof. Arthur Grollman, who is professor of both medicine and pharmacology at Southwestern Medical College, Dallas, Texas, and is well known for his work on the circulation and on the adrenals. The section dealing with depressants of the central nervous system has been revised by Dr. Donald Slaughter.

The revision has been thorough and must have been a vast labour. Pharmacology is advancing rapidly and nearly all the new advances have been included. It is unfortunate that new revisions of both the British and United States Pharmacopœias are appearing too late to influence this edition, but the pharmacological information is well up to date. Among the newer drugs which appear are streptomycin, folic acid, "Paludrine", tridione, *B.A.L.*, *D.D.T.* and *D.F.P.* (these initials mean as much to the pharmacologist as the full chemical names). There are many references to work published in 1946, but the material must have gone to the printers fairly early in the year or the formula of synthetic folic acid would undoubtedly have been included. In spite of many changes, the general arrangement has not been altered and the critical spirit has been maintained; there is rather more emphasis on practical applications and rather less emphasis on academic experiments with isolated organs.

Text-books almost always show a certain amount of national bias, and it is interesting, and perhaps a little sad, that this one now shows some slight signs of American bias. The section on anthracene purgatives was apparently written in ignorance of Straub's work on senna. Benadryl and pyribenzamine are mentioned, but not antergan and neoantergan. Benzestrol is included, but not dienœstrol. Lanatoside *C* takes the place of digoxin. Most of these differences are superficial and merely serve to illustrate the fact that new discoveries may be applied in slightly different ways in different countries. There can be no doubt that this new edition of Cushny's book maintains a high standard and will be an invaluable source of information both for students and their teachers. Few students will read it all but many will keep it for reference, and it can be warmly recommended for this purpose. J. H. Gaddum

POPULATION OF THE SOVIET UNION

The Population of the Soviet Union

History and Prospects. By Frank Lorimer. (League of Nations Publications. II. Economic and Financial. 1946. II. A.3.) Pp. xiv + 289. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1946.) 15*s*. net.

KNOWLEDGE concerning the U.S.S.R., apart from political opinions of various colours, has been hard to get. We have had invaluable essays, notably by Sir John Maynard and Sir Bernard Parcs, but there has long been a serious need of more information than such reference books as the "Statesman's Year-Book" could find space for. This gives a special value to the publication under review. Dr. Lorimer studies and provides not only the available facts of population and employment, but also, by detailed comparison of data for 1926 and 1939, reviews the dynamics of population changes and movements during this period of vital change.

A Russian population roughly estimated in 1724 as 17,900,000 reached a total of 58,629,000 in 1859, by which year Russians in the Asiatic part had reached 3,424,000. In 1897 the figure was 94,331,000 Russians (6,947,000 in the Asiatic part), to which must be added more than 31,000,000 non-Russians, making in all 125,640,000. For 1914 the total is estimated at 142,389,000, but the terrible years 1917–23 reduced it to 136,102,000, since when it was on the up-grade until the recent War. It passed its 1917 figure in 1926–27, with 11,802,382 east of the Urals. In the 1939 area of the U.S.S.R. there were at the end of that year 173,788,000. We thus have a continuation of a large percentage increase. Projections of population are given which show that war losses in numbers should be made up before 1950, and the 200,000,000 mark passed before 1960. As the population of North-western and Central Europe is expected to decline after 1950, it is estimated that the U.S.S.R. will equal North-western and Central Europe in population by 1970, and is more likely to go on increasing thereafter. The age composition of the population is strikingly different from that obtaining in North-western and Central Europe (figures are given in percentages).

	Young people	Males 20–44	Males 45–64	Females 20–44	Females 45–64	Old people
U.S.S.R., 1939–40	45	18	6	20	7	4
N.W. and Central Europe	32	19	10	19	12	9
Estimated, U.S.S.R., 1970	35	20	9	20	10	6
Estimated, N.W. and Central Europe, 1970	21	18	14	18	14	15

Though it is anticipated that the expectation of life will increase, this extract from the tables shows that the proportion of young people is likely to remain far higher in the U.S.S.R., and the proportion of old people will be much less than elsewhere in Europe.

City growth is as marked in the U.S.S.R. as elsewhere. Moscow doubled and Leningrad nearly doubled during 1926–39, reaching more than 4 and 3 millions respectively. In 1926 Kiev had 513,637; by 1939 nine towns besides Moscow and Leningrad had topped the half-million. In 1926 about thirty other towns had 100,000 or more; in 1939 the number was 71. Figures from German sources for the period of the Hitlerian invasion naturally show enormous reductions, especially for Ukrainian towns.

The amount of sown land per head of the population not only kept pace with population increase in nearly all regions except Belorussia, Karelia, Murmansk and Azerbaydzhan, but actually increased, the average for the U.S.S.R. rising from 0·936 to 1·195 hectares, the increase in the Lower Volga and Don regions and Kazakhstan being outstanding.

The net reproductive-rate, as usual, is far higher in rural than in urban areas, and as the average for the whole of the U.S.S.R. in 1938 was estimated at 1·54, the rural birth-rate is very high indeed. In rural areas women between twenty and thirty-nine are responsible for nine-tenths of the births. In urban areas the number of births to women of less than twenty is slightly larger; those to women of forty and more are much less. The birth-rate in 1938 was as high as 38·3 per thousand and the death-rate was 17·8.

There are 22 maps, 103 tables and 31 figures, and they deal with occupations and industrialization as well as with vital statistics of many kinds. Readers will find the statements of fact invaluable, and perhaps scarcely need to be warned that projections suggesting future conditions are subject to a good many reserves. H. J. Fleure

THE GEOLOGICAL SURVEY OF INDIA, 1846 TO 1947

By Sir CYRIL S. FOX

Formerly Director, Geological Survey of India

NOW that the Empire of India has ceased to exist as a British possession and the control of the services in Hindustan and Pakistan has passed from Whitehall, the records of many British-organised services will be reviewed and then perhaps forgotten. I had attempted to tell the story of the Geological Survey of India ten years ago in my presidential address to the Mining and Geological Institute of India (*Trans. Min. and Geol. Inst. India*, **31**; 1936). It was evident to me then that the beginnings of the Geological Survey of India were not correctly known, and certainly not as represented in the record by Sir Clements R. Markham ("Memoirs of Indian Surveys", p. 216; 1878), nor as given by Sir Thomas Holland in his "Indian Geological Terminology" (*Mem. Geol. Surv. India*, **51**, Part 1; 1926). I began a search for information in India, first among the files of the Geological Survey of India, then in the Record Office in the Secretariat of the Government of Bengal, and finally, on my return to Britain last summer, in the record room at the India Office, Whitehall. The correspondence relating to the engagement of David Hiram Williams and, eventually, after his death, to that of Thomas Oldham and his re-engagement after five years service, show that Oldham was recruited as "successor to Williams", and that, even at the time of his re-engagement by the Honourable Court of Directors of the East India Company, Oldham was addressed as "Geological Surveyor". These facts are quite plain in the dispatches to India and Bengal from London, and may be seen in the Commonwealth Relations Office, King Charles Street, London, S.W.1, through the Superintendent of Records.

Already in 1835 the subject of India's coal supplies for the steamers for inland navigation was under consideration, and this led to the establishment of a Coal Committee in 1836, with Dr. John McClelland (Medical Services) as secretary. The reports of the (Indian) Coal Committee of 1838 and 1846 are well known, but it has so far been practically unknown that John McClelland had conducted correspondence with Charles Lyell and with R. I. Murchison on the question of employing trained geologists in India. The earliest letter I have seen is dated February 10, 1841, from McClelland to Lyell, expressing a desire for a scientific examination of the coalfields of India; the second is dated September 22, 1842, from Murchison to McClelland, in which reference is made to the appointment of Sir H. De la Beche to the post of "geologist of the Ordnance Survey"; and the third is dated May 10, 1843, from Lyell to McClelland, also referring to the establishment of geological surveys in Canada, etc. Then there is a letter, dated August 16, 1843, from the Coal Committee to the Secretary to the Government of Bengal, enclosing the correspondence with Lyell and Murchison, and asking that they might be consulted on this matter of a proper geological survey of India. This was followed by a letter ("Steam", No. 2091, dated September 4, 1843) from the Government of Bengal to the Government of India, with a strong recommendation from His Honour, the Deputy Governor of Bengal. The Government of India, in turn, wrote the following letter:

Home Department
Marine.
No. 13 of 1843.

To
The Hon'ble the Court of Directors
of the East India Company.

Hon'ble Sirs,

We have the honor to submit the accompanying communication from the Government of Bengal respecting the best means of ascertaining, with precision, the hitherto undeveloped resources of the country in the production of coal.

The papers which we transmit will explain to your Hon'ble Court the grounds on which the Hon'ble the Deputy Governor urges the expediency of adopting a system of scientific inquiry both with the view of securing success to such attempts as are made by Govt. and of promoting confidence among private speculators to embark in undertakings for obtaining coal, and in expressing our concurrence in the views and recommendations of His Honor, we beg to request that the selection of the Geologist to be sent out by your Hon'ble Court, may be left to Mr. Murchison, the President of the Geological Society in London.

We have, etc.

Fort William,
The 14th October, 1843.

There then followed a search in England for a suitable geologist to be sent out to India to begin the Geological Survey, and it was not until December 1845 that the following letter was dispatched from London by the Honourable Court of Directors of the East India Company:

Marine Department.
No. 8 of 1845.

Our Governor-General of India in Council.

Para. 1. With reference to your letter No. 13 dated the 14th October, 1843, we have to inform you that we have engaged Mr. D. H. Williams to proceed to India for the purpose of making a Geological Survey of those districts in which Coal Fields are situated, with the view of obtaining accurate information respecting the resources possessed by that country for the production of Coal and determining in what manner they may be best turned to account.

2. Mr. Williams has been strongly recommended to us by Sir Henry De la Beche, Director General of the Geological Survey of the United Kingdom under whom Mr. Williams has been for several years employed. Sir Henry informs us that he has surveyed many of the Coalfields in Wales and in the West of England and has executed very valuable maps and sections relating to them. He also represents him as having been in early life engaged in the working of Collieries and as being perfectly qualified to examine the Coal Districts of India, either geologically, or practically as well as to superintend Coal works.

3. These high testimonials leave no doubt of the fitness of Mr. Williams for the important duty which it is proposed to confide to him, and we trust that his labours will have the effect of ensuring success to such mining operations as Government may think proper to undertake and of encouraging private speculators to embark in similar attempts.

4. Mr. Williams left England with the mail of the 20th of the present month (Decr.) and will proceed to Calcutta to place himself under the orders of your Govt. The period of his engagement is limited to five years. He is bound to serve in any part of the East India Company's Territories to which you may direct him.

5. We have agreed to allow him a salary of £800 a year to commence from the date of his arrival in India exclusive of such travelling allowances as you may think reasonable; and we have also granted him £200 in aid for

his outfit and passage to India, and we have guaranteed him the like sum for his return to this country on the expiration of his period of service. He has also been furnished with a set of Instruments such as he is likely to require in India, in order that he may not be prevented from entering immediately on his duties. These instruments, a list of which is transmitted, are similar to those used in the Geological Survey of Great Britain and have been selected by Sir Henry De la Beche.

6. One of the parts of the Deed of Covenant entered into by Mr. Williams is forwarded in the packet for your information and guidance.

We are, etc.

London,
23rd Decr., 1845.

David Hiram Williams arrived in Calcutta on February 4, but did not report for duty, by letter, until next day, February 5, 1846. He was instructed by the Government of India (letter No. 134, Home Dept., Marine, dated February 7, 1846) to place himself at the disposal of the Government of Bengal, and by this Government posted to the Raniganj area. Williams' first field report, from camp at Raniganj, is dated March 31, 1846, and his first progress report, from Spence's Hotel, Calcutta, is dated August 10, 1846. From this report it is evident that Williams had noted: par. 4, the Coal Measures resting directly on the crystalline rocks; par. 7, two groups of coal seams—one with ten seams of coal around Raniganj and the other with fourteen seams of coal near Taldanga near the Barakar River; par. 8, coal near Induhghur (Jharia town), four miles south of the Fitcoory bungalow (ruins near Dhanbad at the Grand Trunk Road—he thus discovered the Jharia coalfield); par. 11, the importance of railway communication; and in a later field report, dated May 3, 1847, he records that the coal near Taldanga was of caking (coking) quality. His last known report is dated December 9, 1847. Williams had planned a series of investigations up the Damodar valley and had secured geological assistants—Mr. Haddon and Mr. Jones—when he contracted jungle fever and died in Hazaribagh in the house of Dr. Callum on November 15, 1848. And, while R. G. Haddon was reporting this sad affair and assuming charge of the Geological Survey at Hazaribagh on November 15, 1848, the body of J. R. Jones, the other assistant, was brought in in a palki. When Williams' death was reported to the Honourable Court of Directors in London in a letter dated January 31, 1849, they replied (letter No. 24, Marine Dept., dated Nov. 28, 1849) to "Our Governor of the Presidency of Fort William in Bengal" complaining of delays in the transmission of reports and as not having news of Williams' death until the autumn of 1849. They record their appreciation of the work done by Williams and propose to publish his reports, and desire McClelland to continue the work, while they add that:

> Para. 6. We propose to take immediate steps for securing the services of a suitable successor to Mr. Williams.

and ending "We are your loving friends . . . etc.".

Their next letter (No. 27 of 1850, Marine Dept., Dec. 11) to "Our Governor General of India in Council" includes

> "We desire that the earliest attention of the Geological Surveyor (Professor Oldham) whom we have lately appointed, and who will proceed to India this month, be directed to the subject."

The subject was the introduction of railways in various areas such as those to which Williams had directed attention. Then their further letter (Marine Dept., No. 9, March 5, 1851) to "Our Governor of the Presidency of Fort William in Bengal" followed with the counterpart of the covenant entered into by Prof. Oldham,

> ". . . lately attached to the Irish Branch of the Geological Survey of the United Kingdom whom we have approved to the situation of Geologist, in succession to the late Mr. D. H. Williams . . ."

In the above letter reference is made to their letter No. 24 of November 28, 1849, showing they had chosen "a suitable successor to Mr. Williams" as early as possible. Previous to Oldham's arrival in India (March 5, 1851), McClelland had carried on the duties which Williams had begun, and McClelland submitted the annual "Report of the Geological Survey of India for 1848–49". He had designated himself as 'officiating superintendent', Geological Survey, and had asked (letter dated March 23, 1850) to be relieved of his geological duties. The Department was therefore (letter dated April 1, 1850) temporarily placed under the charge of the deputy surveyor general, Captain Thuiller, R.E., from April 30, 1850, who addressed Mr. R. G. Haddon as assistant geological superintendent. Thus when Prof. T. Oldham arrived, he was in direct touch with the Surveyor General of India, but he was addressed as Geological Surveyor by the Government of India (letter No. 290, Home Dept., of March 21, 1851, from W. Grey, Esq., Under-Secretary) and informed that his services had been placed at the disposal of the Government of Bengal.

No. 189 dated Fort William, the 24th March, 1851.

From
The Secretary to the Government of Bengal
To
Professor T. Oldham.

Sir,

I am directed by the Deputy Governor of Bengal to transmit herewith, for your information, the accompanying copy of a letter from the Under-Secretary to the Government of India, in the Home Department, No. 291 dated the 21st instant, and to request you to proceed to the Sylhet Hills, with the view of prosecuting your researches there until the season will permit of your examining the Valley of the Damoodah. You will address your reports to this office.

2. At the time of the death of Mr. Williams the Establishment of your office was as following:—

Mr. Haddon	Rs350
Mr. Jones	Rs350
A sub. asst. surgeon	Rs100
A writer and interpreter	Rs50
	Rs850

3. Before Dr. McClelland made overcharge of the office the Establishment was as follows:—

Mr. Haddon	Rs350
Mr. Theobald	Rs100
Mr. Gomes	Rs100
	Rs550

The persons still borne upon your establishment are:—

Mr. Haddon	Rs350
Mr. Gomes	Rs100
	Rs450

4. Mr. Haddon and Mr. Gomes are at present on detailed duty at Purnear. But on your intimating to His Honor that their services will be required by you in your

researches in the Sylhet Hills, they will be directed to join at Sylhet, or Cherra forthwith.

5. You are requested to report upon the establishment you may think it necessary to employ.

I have the honor, etc.,
W. Grant,
Secretary to the Govt. of Bengal.

So Prof. Thomas Oldham entered upon his duties as 'geological surveyor' in succession to Mr. D. H. Williams, and when his period of five years expired and his services were secured by his re-engagement for a further period of five years, the Honourable Court of Directors of the East India Company wrote as follows (letter, India Public Dept., No. 16 of March 5, 1856):

"· · ·

Para. 2. The duties of the Geological Surveyor have been greatly enlarged since Mr. Oldham assumed charge of the office and the establishment which he has to control has been likewise increased owing to the simultaneous prosecution of geological researches in different parts of the country. In consideration, therefore, of the greater labor and responsibility thus attaching to the office, and of the experience which Mr. Oldham has now acquired, we sanction the increase of his salary from the present rate of Rs888 to Rs1,100 per mensem.

Para. 3. We observe with some surprise that the President in Council, as one of the reasons for the increase of Mr. Oldham's salary states that he is paid little more than his assistants. . . .

Para. 4. We take this opportunity of observing that we have not received so regularly as we would desire, reports of the progress of Mr. Oldham's labors. We are apprehensive that the operations of the Department may not have been carried out in a systematic and regular plan. We think it desirable that you should direct your attention to the importance of giving such a character to the work on which Mr. Oldham is engaged, as the only means of rending his employment personally useful and we desire that, in communicating to him his re-engagement you call on him to submit a general scheme in which his future investigations should be carried on, and that when a plan of observations shall have received your sanction, it should be adhered to with as little deviation as possible. We desire a full report of his past labors and any maps he may have made be sent to us.

We are your affectionate friends,

· · ·"

I think that the correspondence I have quoted and referred to will make it very evident that India owes a great debt to Dr. John McClelland in initiating a Geological Survey and very much more to the Honourable Court of Directors of the East India Company in providing the personnel and in taking a close interest in the establishment of the department on sound lines, also to the Government of Bengal for the consideration they showed Oldham after the losses suffered by the deaths of Williams, Jones and, soon after, Haddon, from the effects of jungle fever. It may be, and has been, claimed that in the century completed by the Geological Survey of India on February 5, 1946, the whole of India should have been thoroughly examined and mapped. That this could have been done only by having a large staff and elaborate equipment will be seen from the fact that an experienced geologist can map about 500 square miles a season on an average. There have been, roughly, a hundred and twenty geologists with average field service of barely eight years each, so that the area that could have been mapped is about 500,000 square miles, which was barely a third of the Indian Empire. This does not allow for all the detailed work that has been carried out, and in spite of which the Geological Survey of India had examined practically the entire region of India, part of Burma and some adjacent countries, by the end of its centenary year 1946. Instead of a cadre of thirty to forty officers, the department was already in need of three hundred to four hundred officers at the outbreak of war in 1939 to conduct a thorough economic exploration and exploitation on the lines which Mr. David Hiram Williams was to follow, to say nothing of the important branch of water-supply and of questions of engineering geology.

THE BRITISH-KENYA MIOCENE EXPEDITION, 1947

ONE of the discussions at the Pan-African Congress on Prehistory, which took place at Nairobi in January of this year, was concerned with the fossil remains of Miocene apes which have been found in Kenya during recent years. Some of the delegates to the Congress also visited Rusinga Island (near the Kavirondo Gulf of Lake Victoria) where Early Miocene deposits particularly rich in such fossils had been discovered by Dr. L. S. B. Leakey and Dr. D. G. MacInnes of the Coryndon Museum, Nairobi. It was here that Dr. Leakey found in 1942 a practically complete mandible of the extinct anthropoid ape, *Proconsul*, originally described on the basis of portions of the jaws and teeth discovered at Koru by Dr. A. T. Hopwood.

The opportunities provided by the Pan-African Congress served to focus attention on the great importance of these Miocene sites, and as a result a British-Kenya Expedition to Rusinga Island was organised with the aid of a grant of £1,500 from the Royal Society supplemented by a gift of £250 from the Aga Khan. The expedition was led by Dr. Leakey as field director, with the assistance of Dr. MacInnes as palæontologist. A very detailed geological study of the Miocene beds in the island was included in the programme, in order to supplement the preliminary survey carried out by Dr. P. E. Kent in 1934–35 (see *Quart. J. Geol. Soc.*, **100**, 85; 1944). The geological work of the expedition was supervised by Dr. R. Shackleton, of the Imperial College of Science and Technology, London. While the expedition concentrated its attention on Rusinga Island, brief reconnaissance work was also carried out at Mwafangano, Karungu, and on the Uyoma mainland, and a few days were spent on the Miocene site at Songhor. Work was begun on July 10 and the season ended on November 13.

The principal aim of the Expedition was to obtain further remains of the Early Miocene fossil Hominoidea, and to collect the associated fossil fauna and flora in as much detail as possible for a correlated study of the contemporary environment. Full reports of the season's work will take some time to prepare, but it is now possible to say that the results have been eminently satisfactory. More than 1,300 fossils have been collected, and these include about thirty more specimens of the fossil Hominoidea (probably representing five different genera). Among the more important hominoid discoveries are the palate and mandible of a medium-sized ape (regarded provisionally as *Xenopithecus*), a part of a mandible (including the symphysis) of an ape considerably larger than *Proconsul*, the left half of a palate of an infant Hominoid probably referable to *Proconsul*, and some fragments of limb bones.

The last are likely to be particularly instructive since almost nothing is yet known of the skeletal anatomy of Miocene apes or of their limb proportions. There are already available from Miocene deposits in Kenya an almost complete femur of a large primate (presumably *Proconsul*), as well as the shaft of the humerus, a portion of the clavicle, and some tarsal bones. These are in course of examination in the Department of Anatomy at Oxford; if their reference to *Proconsul* is correct, they indicate that, while from the size of its jaws and teeth it is apparent that this fossil ape approximated to the chimpanzee in its general size, it was of much lighter build and a much more active and agile creature. The femur shows a remarkable resemblance to the femur discovered at Eppelsheim at the beginning of the last century and commonly regarded as the remains of a large gibbon-like ape of early Pliocene date. The humerus, also, is similar to that of the Miocene ape, *Dryopithecus fontani*, described by Lartet in 1856.

The associated fossils collected at Rusinga during the expedition include (1) the greater part of the skeleton of a member of the Rhinocerotidæ (allied to, but distinct from, *Aceratherium*), (2) a considerable quantity of remains of a giant Hyracoid, probably referable to *Pliohyrax*, (3) a number of specimens of *Myohyrax*, including a nearly complete skull, (4) very numerous fossil rodent remains, (5) remains of carnivores, anthracotheres, chalicotheres, insectivores and Suidæ, (6) numerous plant remains, (7) numerous fossil fish, (8) a large collection of myriapods and gastropods, and some pelecypods. As soon as this rich collection has been sorted out and catalogued, the several groups which it contains will be allocated to different laboratories for detailed study.

That so much important fossil material has been collected in one season's work is a tribute both to the richness of the Miocene deposits on Rusinga Island and to the energy and skill of the members of the expedition. The discovery of remains of Early Miocene apes of a generalized kind is of particular significance, since they are likely to throw important light on the evolutionary radiations of the whole group of the Hominoidea. For this reason, it is earnestly to be hoped that funds may be forthcoming for another season's work in 1948. There is a reasonable certainty that this would procure still more limb bone material of Miocene Hominoids; but it is also of the greatest importance to search for parts of the skull (in addition to the mandible and maxilla, of which some remains have already been obtained).

Another consideration arises from the outstanding discoveries in Kenya of Dr. Leakey and his associates, not only of primitive fossil apes but also, in the field of archæology, of early remains of man and his palæolithic cultures. This is, that they are now attracting the attention of prehistorians and palæontologists in other countries. It has recently been reported in the Press that a well-equipped expedition from the University of California is now on its way to East Africa to operate on sites such as those discovered by British investigators, and no doubt other expeditions of a similar kind may be expected in the future. I would therefore urge the desirability of establishing in East Africa an Archæological Survey, with an adequate staff and appropriate financial resources, to organise facilities for, and to co-ordinate the activities of, expeditions into this territory. It is much to be hoped that serious attention will be given to this urgent problem.

W. E. LE GROS CLARK

PHYSICO-CHEMICAL ASPECTS OF CHEMICAL CARCINOGENS

By WILLIAM ANDERSON

Research Department, Glasgow Royal Cancer Hospital

Experimental

SINCE it was first demonstrated that cancer could be induced by a pure chemical compound, the mode of action of chemical carcinogens has been studied from many different points of view and numerous theories have been evolved from the results of controlled experiments on these substances[1,2]. The following observations present yet another aspect from which the problem may be considered.

A large number of the carcinogenic compounds possess no functional group in their molecules and it is therefore difficult to understand how they can bring about the malignant change in a cell by a purely chemical interaction. Furthermore, although the metabolites of many of the substances are derivatives containing hydroxyl groups, the evidence available indicates that hydroxylation causes a diminution of the carcinogenicity of the parent substances[3]. Consequently, some physicochemical explanation of the mode of action of carcinogens was sought. The idea occurred that carcinogenesis by chemical compounds, in particular the polycyclic aromatic hydrocarbons, might have its origin in a chemiluminescence accompanying the hydroxylation of the substances *in vivo*. This concept seemed feasible since it is known that electromagnetic radiations can bring about malignant transformation, and on the other hand, that oxidation of certain organic compounds is accompanied by the emission of radiation. It is also interesting to note that, simultaneously, other investigators have been led to suggest similar ideas[4,5]. It was decided in the first instance to study the reactions of the polycyclic aromatic hydrocarbons under the influence of hydroxylating agents.

Among the reactions accompanied by chemiluminescence described by Trautz[6] are oxidations with chlorine or bromine water of anthracene, phenanthrene and chrysene dissolved in hot alcohol saturated with potassium hydroxide. These reactions were repeated substituting various other hydrocarbons for anthracene, etc., and in each case chemiluminescence was observed. The compounds tested were: naphthacene, 1 : 2 : 5 : 6-dibenzanthracene, 9 : 10-dimethyl-1 : 2-benzanthracene, 20-methylcholanthrene, and 3 : 4-benzpyrene. The luminescence was momentary, due to the fact that an aqueous medium was added to a solution of the substance in alcohol whereby the material was thrown out of solution. The possibility that the radiation might be a crystalloluminescence was not borne out by control precipitation of the substances with water alone. It is likely that these oxidations were due to the formation of hypochlorite or hypobromite, since chemiluminescence could also be produced by adding an aqueous solution of sodium hypochlorite to the substances dissolved in alcohol.

The next reagent used was perbenzoic acid in chloroform solution, since Eckhardt[7] has described reactions between this hydroxylating agent and several hydrocarbons. Attempts to produce chemiluminescence with 3 : 4-benzpyrene using this reagent proved unsuccessful, but when the perbenzoic acid solution was added to a concentrated solution of 20-methylcholanthrene in chloroform, both solutions being heated to 50° C., a chemiluminescence lasting for three seconds was observed. A similar result was obtained from anthracene, when the luminescence persisted for thirty seconds. When further attempts to produce chemiluminescence with 3 : 4-benzpyrene and 9 : 10-dimethyl-1 : 2-benzanthracene failed, investigations using this reagent were stopped, since the technique was proving costly in hydrocarbons. A possible explanation of the fact that chemiluminescence was observed with anthracene and methylcholanthrene but not with the other hydrocarbons is to be found in Eckhardt's observations, which show that the rates of oxidation of methylcholanthrene and anthracene are the two fastest among those of the numerous compounds which he studied.

Various attempts had been made to produce chemiluminescence using hydrogen peroxide as the oxidizing agent, since it has been suggested[8] that the hydroxylation of hydrocarbons which occurs *in vivo* operates through a hydrogen peroxide system. These attempts were fruitless until the Milas[9] reagents were used, in which the hydrogen peroxide is incorporated in tertiary butyl alcohol and osmium tetroxide is employed as catalyst. With these reagents chemiluminescence has been so far observed with the following hydrocarbons: naphthalene; anthracene, phenanthrene, naphthacene, chrysene, 3 : 4-benzpyrene, 9 : 10-dimethyl-1 : 2-benzanthracene, and 20-methylcholanthrene. To observe these phenomena, the following technique was used: a solution of the substance was made in the (6 per cent) hydrogen peroxide–tertiary butyl alcohol reagent[9] by warming the solvent with the substance and filtering to remove the undissolved excess. To 5 ml. of this solution was added 0·5 ml. of a 0·5 per cent solution of osmium tetroxide in tertiary butyl alcohol. The radiation emitted was observed in a completely dark room, the observer having accustomed himself to the darkness for 15–20 min. prior to making the observation.

In contrast to the reactions with chlorine and bromine water described above, no precipitation occurs here and the chemiluminescence persists for 15–80 sec., so that the reactions are suited to controlled experiment. The experiments with the other reagents had been conducted at raised temperatures (50°–80° C.), but with the Milas reagents radiation has been observed at 37° C. with certain of the hydrocarbons. Several of these oxidations have been studied more fully, and fluorescence spectra of the reaction products together with solubility in alkali indicate the presence of hydroxylated derivatives. Further details of these investigations will be published elsewhere.

The question then arose as to whether the other chemical structures which fall within the classification 'chemical carcinogens' would emit radiation in similar reactions. Metabolism studies show that 2-acetylaminofluorene undergoes hydroxylation in the rat[10]; and although investigations on the azo-dyes suggest that the main metabolic changes which occur are other than hydroxylation, it is perhaps significant that Stevenson, Dobriner and Rhoads[11] isolated *p*-aminophenol from rats dosed with Butter Yellow (*p*-dimethylaminoazobenzene), indicating hydroxylation at some stage in the metabolism. Chemiluminescence was observed using Milas reagents with 2-amino- and 2-acetylaminofluorene, and with Butter Yellow, the N-monomethyl compound, the free base, and *p'*-methyl-N : N-dimethyl-*p*-aminoazobenzene. Tests on other structures showed that radiation is emitted during the reactions with *p*-dimethylaminostilbene and 'styryl 430' [2, (*p*-amino styryl) 6, (*p*-acetylamino benzoylamino)-quinoline methoacetate] and with 3 : 4 : 5 : 6-dibenzcarbazole and its N-methyl and N-ethyl derivatives.

The spectra of the radiations from the reactions have not yet been recorded, since the light is of very low luminosity under the experimental conditions obtaining, but work in this direction is in progress. The radiation so far observed has been in each case a weak green or greenish-white light, with the intensity varying from substance to substance and with the temperature of the reaction mixture. It is possible to grade the intensity of the radiation from a given reaction as weak, medium bright, or bright; but these data have not been recorded here, since obviously they would bear little relation to the intensity of the radiation from a similar reaction occurring *in vivo* where the reactions are of a heterogeneous nature. It might be remarked, however, that a chemiluminescent reaction occurring in the cell would be expected to have a high radiochemical yield, since the molecule when reacted upon will be adsorbed to some chemical structure in the cell (see below), and will therefore be unable to rid itself of excess energy by collision with other molecules to the same extent as occurs in the homogeneous reaction conducted in the test tube.

Theoretical

The observations set out above indicate that similar processes may occur during the reactions on the chemical carcinogens which take place *in vivo*. If we consider the emission of radiation during reaction to be one of the factors concerned in chemical carcinogenesis, and, indeed, to be the factor which originates the breakdown of the stable economy of a cell or a group of cells, we can evolve a theory which allows some degree of correlation of the great mass of scientific data, chemical and biological, on the subject, and which at least lends itself to further deduction and experimental test.

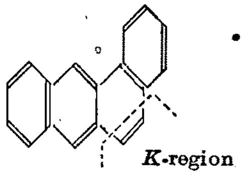
The experiments in chemiluminescence show that here is a phenomenon associated with the oxidation of all the major groups of chemical carcinogens, and the concept that this property initiates the malignant change, at once, finds a common factor for the different series of compounds, and explains, in part, the failure of attempts to correlate chemical structure and carcinogenic action. Furthermore, a theory on this basis provides a link between the chemical carcinogens and the physical carcinogens. That this is a satisfactory link is suggested by the fact that, histologically, tumours induced by chemical and physical carcinogens are remarkably alike, while in some cases they can be distinguished from virus-induced tumours[12,13,14]. The mechanism visualized is as follows: molecules of the chemical carcinogen are supplied continuously over a time period to a localized group of cells by painting the carcinogen on a given area of the skin, or by subcutaneous injection of an oily solution, or by feeding. These molecules pass into the framework of the cells and at some particular point in the cell they come into contact with a hydroxylating system. In the ensuing reaction radiation is emitted and some molecules are hydroxylated. The radiation which is liberated inside the cell is then absorbed by some other molecule of the cell structure, and presuming the radiation to be in the visible or near ultra-violet regions of the spectrum it will cause electronic transitions in this molecule. The result of these transitions will depend on several factors, such as the frequencies of the light absorbed, the strength of the particular chemical bonds affected, and the means which the energized molecule has at its disposal to lose the extra energy; but, at any rate, certain chemical bonds will be momentarily weakened or made more reactive. It may be that, at a certain juncture during the life of the cell, a state of affairs obtains in which the cell structure is under greater strain than normally, and activation of particular chemical bonds by radiation at this time will be effective in producing some structural change; such a juncture is reached during mitosis.

Reference should be made at this point to the interesting article of Haddow[2] on the energetics of the malignant transformation, where he shows that evidence drawn from different sources suggests that the change from normal to malignant cell may be related to some change of energy-level in a certain part of the cell.

In the different studies designed to discover the mode of action of chemical carcinogens an attempt has always been made to relate the carcinogenic potency of the different substances and the extent to which they exhibit the particular property under consideration. The difficulty of making a significant comparison in this way becomes apparent when we come to realize that many factors contribute to the meaning of the apparently straightforward phrase 'carcinogenic potency'. In furtherance of the theory of carcinogenic action proposed above, certain facts which might explain the so-called carcinogenic potency of a substance will be considered.

A point of considerable interest which has emerged from the careful metabolism studies on the hydrocarbons is that the hydroxy-metabolites have the hydroxyl radicals in positions which are not the most chemically reactive ones[15]. The inference from this is that in the reactions which occur *in vivo* the most reactive positions are in some way blocked; and the suggestion has been made that prior to the reaction the molecule is adsorbed to some part of the enzyme system which effects the hydroxylation[16]. This idea is much favoured by the observation that, while the mechanism of enzyme catalysis is not fully understood, one feature which is agreed upon is the formation of an enzyme-substrate complex[17]. This interpretation is given a new significance when it is considered in conjunction with the recent work of the Pullmans[18], who claim that a relationship exists between the carcinogenic activity of a substance and the value of the electron density about a specific bond in the molecule of the substance. The attempt to obtain evidence that such a relationship exists was initiated by Schmidt[19], who also suggested an interpretation[20]. Schmidt's idea is that hydrocarbon molecules possess a region where the electron density is higher than at other parts of the molecule, and that if this density exceeds a certain value the substance is a carcinogen. Carcinogenesis is then supposed due to an interaction between the region of high electron density and some protein molecule whereby a quantal change in the protein molecule is facilitated. The mathematical treatment has been modified and placed on a firmer basis by the Pullmans, while Schmidt's discussion on the significance of the results has been revised by Daudel[21].

The results of the Pullmans' work are capable of an alternative explanation which is supported by chemical facts. A high concentration of electrons about a specific region in a molecule will confer on that region the property of greater reactivity; thus the K-regions to which the Pullmans refer in the hydrocarbons are the most reactive positions in the molecules. When we consider this in the light of the metabolism studies, we see that these K-regions are the positions by which the hydrocarbon molecules will be attached to the enzyme system, thus leaving the positions of secondary reactivity to be hydroxylated. Furthermore, evidence in support of the likelihood of this type of complex formation is offered by the studies of Weiss on the complexes formed between the hydrocarbons and quinones (or polynitro compounds)[22] and on the salts of these hydrocarbons with different acids (perchlorate, sulphate, pyrophosphate)[23]. In both types of structure there is an electron transfer from the hydrocarbon to the other component of the complex and the formation of a linkage of an ionic nature. Such an electron transfer would originate at the K-region of the hydrocarbon molecule. The suggestion is therefore made that the significance of the presence of regions of high electron density in the molecules of polycyclic aromatic hydrocarbons is that it provides them with a means whereby they can attach themselves to a particular enzyme system within a given cell. Since the calculations of the Pullmans have been extended to include other carcinogenic structures, it is possible that a similar explanation might hold in these cases also. If, indeed, a relationship exists between the electron density values at these regions of the molecules and their carcinogenic potency, this would indicate that the ease with which the molecules of a substance can be adsorbed by a particular enzyme system plays a major part in deciding the carcinogenic potency of a compound, and whether it will be a carcinogen at all.



Let us now consider the idea that chemiluminescence is the direct factor causing the malignant change in conjunction with the idea that the ease with which a substance can be adsorbed to a particular enzyme system is the direct factor deciding the relative potency of the substance as a carcinogen. We are then in a position to offer a simple explanation of three interesting facts: (1) that certain chemical substances are carcinogenic, (2) that there are differences in the carcinogenic potency of these substances, (3) that compounds closely related in chemical structure to the carcinogens have no carcinogenic activity. We may suggest that a chemical compound will be carcinogenic if, during its metabolism, sufficient energy in the form of radiation of a particular set of wave-lengths is liberated. The potency of a carcinogen will be dependent on the ease with which it can attach itself to a particular enzyme system; the more easily the molecule is adsorbed, the more readily will the reaction proceed and energy be liberated, thereby presenting a greater probability for structural change in the cell. When the ease of adsorption and consequently the rate of metabolism falls below a certain value, the risk presented to the cell structure is too small and the substance is a non-carcinogen.

The term 'carcinogenic potency' must be interpreted cautiously. Indeed, the relative potency of a carcinogen varies from one cell type to another, and we must qualify the above ideas to cover this point. If the potency of a carcinogen is dependent on the amount of energy liberated during a given time period, it will be directly controlled by the rate of the metabolism of the substance. Other factors which will influence the rate of metabolism of a compound besides ease of adsorption to the enzyme system responsible for the reaction are the ease with which the molecules of the compound can reach that system, and the ease with which the reactants can be desorbed and removed from it to allow for further reaction. These properties will depend on the precise spatial configuration of the molecule of the carcinogen and of the cell structure, and on the intimate interactions between these. It follows that differences in cell structure will affect the rate of metabolism of the carcinogen; it is inferred that they will thus affect the potency of the carcinogen.

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OBITUARIES

Prof. P. Lenard

PHILIPP LENARD was born at Pozsony (Pressburg) in Hungary on June 7, 1862. In the town of his birth he was fortunate in finding an excellent teacher of physics, Virgil Klatt, in conjunction with whom he later carried out his first work on phosphorescence. As a young man he studied physics at the Universities of Budapest, Vienna, Berlin and Heidelberg under, among other famous teachers, Bunsen, Helmholtz, Königsberger and Quincke, obtaining a thorough all-round knowledge of theoretical as well as experimental physics. His first senior appointment was, in fact, as professor of theoretical physics in Heidelberg in 1896; two years later he was made professor of experimental physics at Kiel, where he remained until recalled to Heidelberg in 1907 to be Quincke's successor as professor of experimental physics. In 1909 he was made in addition director of the newly founded Radiologisches Institut, which was more or less amalgamated with the physics research laboratory of the University. He remained as professor at Heidelberg until his retirement in 1931. News has recently reached England of his death on May 20, 1947.

Lenard's first paper was on the vibrations of water drops, recalling the fact that Bohr's first paper was the determination of the surface tension of water by jet vibration, and his researches covered a wide field, but he is best known by his pioneering work on cathode rays and electron physics in general. Hertz, whose assistant he was at the time, had shown in 1892 that cathode rays would pass through thin metal foils. Lenard followed this up, and in 1893 succeeded in making a cathode ray tube with a very thin vacuum-tight metal window, with which he obtained outside the generating tube a beam of cathode rays which could either be passed through gases or solids, or be tested in the highest attainable vacuum. His systematic experiments on the passage of cathode rays through matter showed that the absorption was roughly proportional to the density and, further, that it decreased very rapidly with increasing velocity of the rays. He proved that cathode particles of high energy could pass right through atoms, and explained this by his theory that the positive and negative changes within the atom were grouped in tight couplets, which he called 'dynamids'. This theory was, of course, shown to be untenable by Rutherford, but nevertheless Lenard was the first to insist on the charges being grouped so that the space within the atom was relatively empty and penetrable by fast particles. Lenard was the first to prove that the negative electricity released in the photo-electric effect consisted of electrons, although J. J. Thomson's independent demonstration appeared very soon after. For his work on cathode rays he was awarded the Nobel Prize for Physics in 1905.

Lenard was also a pioneer in the field of ionization potential, being the first to show that an electron must possess a certain minimum energy before it can produce ionization. His earliest estimate of 11 volts as the ionization potential of hydrogen, nitrogen and oxygen was a very good one for the rough methods then available. His original experimental disposition was the pattern for many subsequent methods. Another field in which Lenard carried out fundamental work was phosphorescence. First of all in conjunction with Klatt, and later alone and in conjunction with Wilhelm Hausser and others, he studied in great detail the preparation, excitation and emission of light with the alkaline earth and zinc phosphors. In these investigations it was established that the light emission was due to small traces of foreign metal in the sulphide, for example, calcium sulphide, which constituted, with a flux, the bulk of the material, and Lenard put forward the theory that the excitation involved the removal of an electron from the metal atom, which electron was held in certain ways in the surroundings until subsequently released, when its return to the metal atom caused light emission. This is the general basis of the theory now accepted. He also established experimentally that the process was of a quantum nature and, in general, laid the basis for the precise quantitative study of the subject.

He carried out important work in many other directions. He worked out the method of measuring magnetic fields by the bismuth spiral, his work on the electrification caused by splashing was important in its time and he was actively concerned with the electrical properties of flames. Mention must also be made of the important body of work which he carried out, mainly in conjunction with Ramsauer, on the ionization produced by ultra-violet light, which is not known as widely as it might be.

Lenard was personally a difficult man, whose character contained many contradictions. An intimate friend of mine who knew him well once wrote to me: "Was Lenard betrifft, so ist er so klug und so dumm wie immer". He was profoundly disappointed not to have discovered the Röntgen rays, which he had almost under his hand and would have in all probability found within a year or so of the actual date if Röntgen had not anticipated him. He never used Röntgen's name in referring to the rays. He took as a personal affront any inadequate acknowledgment of his work and was incapable of any generosity or even justice towards anyone who, in his opinion, had failed to appreciate any part of his services to science. Although he owed much of his success to Jews, for example, Hertz and Könisberger, and at one time freely acknowledged the debt, he became a bitter anti-Semite and even treated Einstein as not far from an impostor. He refused to fly the Institute flag at half-mast when Rathenau was murdered and was with difficulty saved from popular indignation. He became a whole-hearted supporter of the Nazi regime and of the 'German physics' movement: in fact, he wrote a book called "Deutsche Physik". Yet he had a kindly side to his nature and was often a pathetic rather than a menacing figure. He possibly felt a deep personal need of friendship which he was unable to win or, if he could win it, to retain. His lack of trust in others, his failure to awaken the self-reliance or sympathy of those working under him were the cause that he did not found a great school of physics. It has been suggested, probably correctly, that the clue to his character was that he was a weak personality that sought to protect itself by a hard shell.

As an experimental physicist, Lenard was certainly one of the greatest figures of his time. His work on the physics of the electron was distinguished by a masterly experimental technique and his discoveries had a profound influence on the course of physics, in particular his work on the release of electrons by electron impact and by light. Yet he seemed fated never to achieve supreme greatness. He missed the discovery of Röntgen rays; he came near to the discovery of the true structure of the atom, but just went astray, and his work on light emission was the first to indicate the important part which the release and return of the electron played, but left to Bohr the great advance. He was a whole-hearted enthusiast for experimental physics, whose appreciation of the great men of science of the past times was generous and informed, as can be seen from his book "Grosse Naturforscher" (translated into English under the title "Great Men of Science"). He was a dark genius beclouded by strong personal fears, doubts and envies, but undoubtedly a genius and one who has left an abiding impression in physics.

E. N. DA C. ANDRADE

WE regret to announce the following deaths:

Dr. C. C. Hurst, of Cambridge, known for his pioneer work in genetics, on December 17, aged seventy-seven.

Sir Bernard Spilsbury, honorary pathologist since 1934 to the Home Office, on December 17, aged seventy.

Mr. Benjamin Talbot, Bessemer medallist in 1908 and president in 1928 of the Iron and Steel Institute, on December 16, aged eighty-three.

NEWS and VIEWS

Committee on Industrial Productivity

IN answer to questions in the House of Commons on plans for further development of scientific research to assist industrial production, Mr. H. Morrison, Lord President of the Council, stated on December 18 that he is advised that, while a major contribution to industrial productivity cannot be expected in the short run from current research in the natural sciences, there are considerable possibilities of increased returns, first from the more widespread application of research already carried out in the natural sciences and technology, and, secondly, from current research in the social science field. He had, therefore, decided, in consultation with the Chancellor of the Exchequer, to supplement the work of the Advisory Council on Scientific Policy by setting up a new Committee on Industrial Productivity. The terms of reference of the Committee are: "To advise the Lord President of the Council and the Chancellor of the Exchequer on the form and scale of research effort in the natural and social sciences which will best assist an early increase in industrial productivity, and further to advise on the manner in which the results of such research can best be applied". The main work of the Committee, of which Sir Henry Tizard will be chairman, will be conducted through a number of panels constituted from time to time to investigate and report on various aspects of the problem. In the first instance panels are being set up to deal with technology and operational research under the chairmanship of Sir William Stanier; import substitution, under Prof. S. Zuckerman; the human factors affecting industrial productivity, under the chairmanship of Sir George Schuster; and technical information services, under the chairmanship of Dr. Alexander King. The remaining members of the Committee will include one or more employers (chosen in consultation with the F.B.I. and the B.E.C.); one or more trades union members (chosen in consultation with the T.U.C.); Sir Edward Appleton; Sir Claude Gibb; Mr. Hugh Weeks; Mr. Robert Hall; Mr. E. M. Nicholson; Mr. G. B. Blaker; secretary, Mr. E. D. T. Jourdain.

'Flying Wing' Aircraft

INFORMATION has just been released that an aircraft of the 'flying wing' type has completed its trial flights at Bitteswell Aerodrome, near Rugby. It is known as the *A.W.52*, built by Messrs. Armstrong Whitworth to the designs of Mr. J. Lloyd, their chief designer. The aircraft embodies two fundamental principles, that have developed out of the general progress of aerodynamic research. The abolition of the tail has long been an ideal to some schools of thought. It sets up considerable drag and does not contribute to the performance of the machine, but is necessary for control purposes with the more conventional lay-out of the various aerodynamic surfaces. The Westland-Hill 'Pterodactyl' demonstrated the possibilities of tailless aircraft many years ago. The suppression of as much of the external body as practical requirements of accommodation allow is another obvious trend for the same reason.

Experimental work on high-speed flight has made it evident that swept-back wings are going to be inevitable at transonic and supersonic flight speeds. Again the vital factor appears to be that of control with the less conventional lay-out of the wing surfaces. The *A.W.*52 follows a series of experiments carried out with gliders, and appears to be satisfactory in this respect. Further progress towards even higher speeds should be possible now that greater powers can be envisaged using the internal combustion turbine in conjunction with jet propulsion, and this or similar machines will undoubtedly be used in this way.

Falkland Islands Dependencies Survey

THE Falkland Islands Dependencies Survey has recently acquired a vessel to enable it to carry out its expanding field of work in the Antarctic. The ship, which was named *John Biscoe* by Mrs. Creech Jones, wife of the Secretary of State for the Colonies, on December 16, has a double-skin wooden hull and a displacement of 1,015 tons; she is driven by Diesel-electric power. She carries a crew of twenty-five, and is to take a relief party in the summer to replace about half the party at present occupying the seven observation stations maintained by the Survey in the Antarctic. The new party will carry out geological, meteorological and zoological investigations, and is under the leadership of Dr. V. E. Fuchs, a geologist who has had experience of exploration in East Greenland and in East Africa. The *John Briscoe* has been named in memory of the discoverer of the southern part of Graham Land. The Falkland Islands Dependencies Survey (see *Nature*, March 22, p. 388) was set up under the control of the Colonial Office after the War to take over from the Admiralty the meteorological stations established in the Antarctic in 1943.

Royal Society: Research Appointments

THE Royal Society has appointed Dr. K. Bailey, of the Biochemical Laboratory, Cambridge, to an Alan Johnston, Lawrence and Moseley Research Fellowship for research on the problems of human and animal health and diseases and the biological field related thereto. Dr. Bailey will work at the Biochemical Laboratory in Cambridge on the proteins of muscle fibril. The Royal Society has also appointed Dr. G. S. Dawes, of Worcester College, Oxford, to a Foulerton Research Fellowship in Medicine. Dr. Dawes will work at the Department of Pharmacology, Oxford, on the left ventricle reflex.

Edward Rigby (1747–1821)

EDWARD RIGBY, who was born at Chowbent in Lancashire two hundred years ago on December 27, was a versatile man, distinguished alike in obstetrics, agriculture and civic administration. In medical literature his "Essay on the Uterine Hæmorrhage" (1775) is regarded as a classic, for it clearly differentiated between premature separation of the normal placenta (accidental hæmorrhage) and placenta prævia (unavoidable hæmorrhage). It was translated into French and German, and up to the hour of his last illness the author was employed in the preparation of a sixth edition. A scientific agriculturist, Rigby experimented on his own farm at Framingham Earl, near Norwich, and the reputation of his writings on that subject led to his election as honorary member of the Philadelphia Society. In 1805 he became mayor of Norwich, and he is said to have "supported the chair with dignity and hospitality". He established in 1786 the Norfolk Benevolent Medical Society for the relief of the widows and orphans of medical men, introduced the flying shuttle to the manufacturers in Norwich, and in 1812 started vaccination in the city. Simple, placid and benevollent, Rigby was a delightful companion and a good conversationalist. He died on October 27, 1821, in his seventy-fourth year. His "Letters from France" constitute an animated and fascinating record of the stirring days at the outbreak of the French Revolution, besides forming a useful survey of the country's agriculture at the time. Rigby's son Edward (1804–60) was a well-known London obstetrician.

New Nuclear Reactions

"NUCLEAR Transformations in the new High Energy Ranges" is the title of an address delivered by Prof. Glenn T. Seaborg, of the University of California, at a meeting of the American Chemical Society in New York on September 15 (see *Chemical and Engineering News*, 25, 2819; 1947). The great progress made recently in constructing new powerful machines for the acceleration of charged particles affords the possibility of bombarding targets with electrons of 100 MeV., and with deuterons and helium ions of 200 and 400 MeV. respectively. Entirely new nuclear reactions have been observed; for example, $^{75}_{33}$As, bombarded with 400 MeV. helium ions, produces among other atomic species the well-known $^{38}_{17}$Cl. This means that the arsenic atom has lost no less than 16 protons and 21 neutrons, not counting the two protons and two neutrons shot into it at the start of the reaction. To distinguish such transmutations from the ordinary nuclear reactions in which only one or two particles are ejected, and from fission reactions in which the nucleus is broken into two fragments, the term 'splintering reaction' is proposed. Further, under such strong bombardment fission can be enforced in such elements as bismuth, lead and thallium, and even in an element so low in the periodic table as tantalum; but as the secondary particles emitted have a much smaller energy, there is no possibility of inducing a chain reaction such as in uranium. Many radioactive isotopes so far unknown have been found as a result of these new nuclear reactions, which have still further widened the field radiochemists are called upon to explore; the splintering often leads to neutron-deficient isotopes and increases therefore in a welcome manner the comparatively small number of positron emitters among the artificial radio-elements. Some of them may find application as tracers. Still more important may be the physical aspects of this extension of the energy range; the creation from energy of mesotrons and, if the region of billions of electron-volts can be reached, also of neutrons and protons, seems now a possibility.

Special Libraries in Australia

RAPID growth in the appreciation of the value of accurate and up-to-date information in science and technology was marked during the last decade. This resulted in recognition that the work of librarians in special libraries and of information officers has a character of its own, and in the consequent formation of associations providing a platform for the discussion of common interests. The Association of Special Libraries and Information Services (A.S.L.I.S.) in Melbourne, Australia, is one of these, and it is to be congratulated on the launching of its journal, *Information*, in June 1947. This first issue contains, besides introductory matter, the first part of an article on documentary reproduction, another on patents in information, glimpses of the B. J. Ball, Ltd., library in Melbourne, and the constitution of the Association. An exchange corner for periodicals, abstracts of relevant literature, and questions and answers on the universal decimal classification are other features which will appeal to members. Although printing difficulties may make the appearance of the journal infrequent at first, it has made a good start. It should, perhaps, be mentioned that the Australian organisation A.S.L.I.S. is quite independent of the Association of Special Libraries and Information Bureaux (A.S.L.I.B.) in Great Britain, though the two are in very cordial relationship.

Indians of the South-Eastern United States

THE historical Indian tribes of the south-eastern United States are diverse in language, but they share so many important characteristics that they form a cultural province. This is illustrated by the arrangement of Mr. Swanton's massive work (Smithsonian Institution: Bur. of Amer. Ethnology, Bull. 137. Pp. xiii+943+107 pl. Washington, D.C.: Gov. Print. Office. 2.75 dollars), in which a brief, purely historical sketch of each individual tribe is given first, leaving the material culture to be dealt with as a whole. The book may be considered as supplementing and bringing up to date the relevant parts of the great two-volume Handbook of American Indians North of Mexico, edited by F. W. Hodge, published as Bulletin 30 of the same series in 1907 and 1910. The author regards it principally as a collection of source materials, and as such he hopes that it will be useful to future students. This hope should be fully realized, and in addition it will be a most useful book of reference. Some of the plates are not well chosen. It is difficult, for example, to see what is to be learnt from the rather distant group, in Edwardian dress, in front of a modern wooden building, labelled "Ladies Relief Society of the Church of Jesus Christ of Latter Day Saints, Catawba Reservation" (Plate 5). The space occupied by this and some others might have been better employed in illustrating objects of material culture.

Bibliography of Seismology

VOLUME 13, No. 19 of the *Bibliography of Seismology*, published by Dr. Ernest A. Hodgson from the Dominion Observatory, Ottawa, Canada, covers items 6,047–6,142 and carries the bibliography to the end of June 1946. This valuable publication, which deals with pure and applied seismology and subjects throwing light on them, covers in this issue world books, papers and works published on the Continent of Europe during the years 1939–45, together with a small list of patents. There are fourteen items from Holland including an obituary notice of Dr. G. Van Dijk (1877–1940), L. P. G. Koning on deep focus earthquakes (items 6,094–95), F. H. van Rummelen and S. W. Visser on Dutch earthquakes, and a text-book on seismology by S. W. Visser (items 6,135, 6,137–38). The items from Finland, five in number, consist of four papers on isostasy and one on pure seismology, namely, Eijo Vesanen's "Ueber die typenanalytische Auswertung der Seismogramme" (*Ann. Acad. Sci. Fennicæ*, A, 3, Geologica-Geographica, 5, pp. 244. Helsinki, 1942). Three items from France include obituary notices of Dr. Edmund Rothé and Dan Barfod La Cour and an article on French geophysics during the War. Item 6,107 contains references to a most important topical seismological question, namely, the use of the seismograph as a meteorological instrument; by means of microseisms tropical storm and cyclone centres at sea can be located and tracked. There is a list of the seismological items published in *Nature*.

An Unusual Asteroid

AN asteroid discovered in August by C. A. Wirtanen, Lick Observatory, is described in *Sky and Telescope* of October. Its magnitude at the time of discovery was 15, and it is estimated that its diameter is only a few miles. Its orbit is nearly circular and lies close to that of Mars, approaching the orbit of Mars to within 6 million miles; but its least distance from the earth is about 50 million miles. Its period is nearly 2·3 years—the shortest period of any asteroid with the exception of Eros.

Institution of Mining and Metallurgy: Officers for 1948–49

THE following have been elected officers of the Institution of Mining and Metallurgy for the session 1948–49: *President*, Mr. Sydney E. Taylor; *Hon. Treasurer*, Mr. Robert Annan; *Vice-Presidents*, Mr. G. Keith Allen, Mr. Donald Gill, Mr. V. Harbord, Colonel L. C. Hill, Sir Arthur Smout and Brig. R. S. G. Stokes. Mr. S. E. Taylor, the new president, was educated at Cambridge, where he read engineering science. He joined the technical staff of Messrs. John Taylor and Sons, managers and consulting engineers to mines in many countries, in October 1922, and became senior partner in 1941. In 1924 he visited Brazil, and since 1923 has paid numerous visits to India in connexion with the management of the mines on the Kolar Gold Field in Mysore State, and the re-opening of the Hutti gold mine in Hyderabad State.

Announcements

THE Royal Society is compiling a list of British scientific societies, together with the names of their officers, etc. As it is desired to make this as comprehensive as possible, it would be appreciated if any secretaries of such societies, who have not yet received a questionnaire from the Royal Society, would inform the Assistant Secretary, Royal Society, Burlington House, London, W.1.

TRINITY COLLEGE, Cambridge, offers research studentships and Dominion and Colonial exhibitions every year, and elections will take place in July 1948. Research studentships are open to graduates of universities other than Cambridge who are not more than twenty-six years of age. The exhibitions are open to undergraduates as well as those wishing to undertake research. Applications, to be sent through the head of the candidate's university, must reach the Senior Tutor, Trinity College, Cambridge, not later than May 1, 1948.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Molecular Weight of α-Amylase

PROF. KURT H. MEYER and his co-workers[1,2] have recently succeeded in the crystallization of α-amylase from pig's pancreas. The molecular weight of the substance, kindly supplied by Prof. Meyer, has been determined from sedimentation and diffusion experiments. The dried substance was dissolved in a buffer solution of pH 8·4, with a molarity of 0·2 in sodium chloride, 0·02 in boric acid and 0·005 in borate.

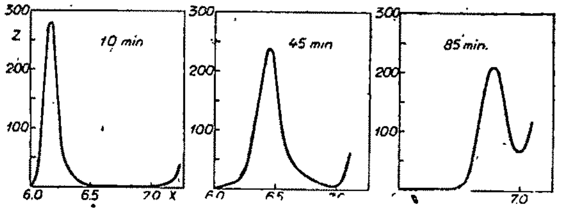

Fig. 1. SEDIMENTATION CURVES FOR α-AMYLASE

Ultracentrifuge measurement. The sedimentation diagrams of Fig. 1 were obtained by centrifuging at 65,000 r.p.m. The diagrams show one definite peak, characteristic of a uniform substance[3]. The concentrations of amylase used are shown in the table.

Conc. of amylase %	s_{20} (in S units)
0·09	4·63
0·18	4·32
0·22	4·44
0·26	4·50
0·30	4·38
0·66	4·64

The value of the sedimentation constant is evidently independent of the concentration of amylase. The average value is 4·50 S.

Diffusion measurement. The determination of the diffusion constant was carried out according to Lamm's scale method[4,5] in a diffusion cell of steel[6]. The resulting curves are shown in Fig. 2.

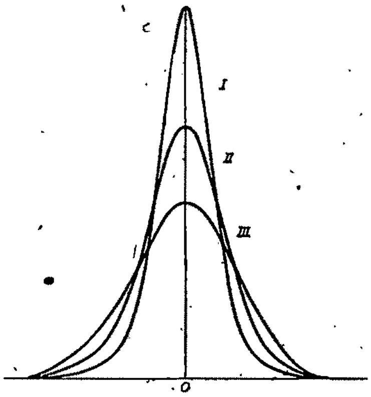

Fig. 2. DIFFUSION CURVES
I, after 20,100 sec.; II, after 42,700 sec., and III, after 80,900 sec.

The diffusion constant was calculated by two independent methods. Values of $D_A = 7 \cdot 89 \times 10^{-7}$ and $D_m = 8 \cdot 19 \times 10^{-7}$ were obtained. Hence, the agreement between the two methods of calculation is good. The average value of $D = 8 \cdot 05 \times 10^{-7}$ is used in the following.

The molecular weight was calculated according to Svedberg's formula: $M = \dfrac{R T s_{20}}{D(1 - V\rho)}$, where R is gas constant, T is absolute temperature, s_{20} is sedimentation constant, D is diffusion constant, V is partial specific volume of the solute, ρ is density of the solvent.

The value of V was 0·70 ± 0·02, kindly determined by Prof. C. Drucker. Using these values, the molecular weight of this α-amylase is 45,000.

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Sept. 2.

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[2] Fischer, E. H., "La purification et l'isolement de l'α-amylase de pancréase", Thèse No. 1094 (Genève, 1947).

[3] Svedberg, T., and Pedersen, K. O., "The Ultracentrifuge" (Oxford, 1940).

[4] Lamm, O., *Nova Acta Reg. Soc. Sci. Upsal.*, Ser. iv, 10, No. 6 (1937).

[5] Lamm, O., and Polson, A., *Biochem. J.*, 30, 528 (1936).

[6] Claesson, S., *Nature*, 158, 834 (1946).

Structure of Starch: Mode of Attachment of the Side-chains in Amylopectin

ESTIMATIONS of the proportion of glucose residues present as end-groups in the amylopectin component of starch have shown that some 5 per cent of the glucose residues occur as terminal groups. Since amylopectin has a high molecular weight, of the order of 10^6, a branched-chain structure must be present in the molecule. The main features of the structure are indicated diagrammatically in Fig. 1[1], where (*A*), (*B*), (*C*), etc., are chains containing on the average 20–24 1:4-linked α-gluco-pyranose residues, each chain being united through C_1 of its first glucose residue to one of the glucose residues in another chain. The location in the chain of this glucose residue is not known, but it is clear that it must have three of its hydroxyl groups, namely, those at C_1, C_4 and at the carbon atom involved in the junction, occupied by linkages to other glucose residues. Two hydroxy groups remain free, and it follows that an investigation of the dimethyl glucose obtained on hydrolysis of a completely methylated amylopectin should enable the mode of linkage to be ascertained. Experiments on these lines showed that 2:3 dimethyl glucose was present in the hydrolysis products[2], and it was inferred that some at least of the side-chain linkages were through C_6 of the glucose residues concerned. Uncertainty is caused, however, by the experimental difficulty encountered in the complete methylation of amylopectin and by the fact that trimethyl glucose tends to undergo some demethylation in contact with methanolic hydrogen chloride. An effort to minimize these difficulties was made by using for the methanolysis a fully methylated but highly disaggregated sample of starch of low mole-

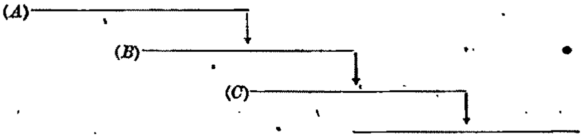

Fig. 1

cular weight[3]. Again, however, 2:3-dimethyl glucose predominated in the dimethyl hexose fraction.

An alternative method of approach was clearly desirable, and this we have endeavoured to provide by a development of the periodic acid method of oxidation of glycols[4]. Inspection of Fig. 2 will show that when the side-chain is attached to C_6 there remain in the glucose residue two contiguous OH groups at C_2 and C_3. Oxidation with periodic acid will therefore disrupt the bond between C_2 and C_3, and after subsequent hydrolysis the sugar residue involved in the branching will no longer be recoverable as glucose. On the other hand, if the side-chain junction is at C_2 or C_3, no α-glycol groupings remain and there will be no attack by periodic acid. In these circumstances the glucose residue remains intact and will be recoverable as glucose after hydrolysis. It follows that oxidation by periodic acid followed by hydrolysis and examination of the products should give information about the mode of linking, provided methods are available for the detection and estimation of small quantities of glucose in admixture with aldehydic and acidic products. These were found in the paper chromatogram method of Partridge[5] and in the recently described quantitative development of this technique[6].

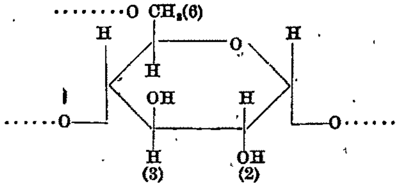

Fig. 2

This procedure has now been applied to starches of various origins, namely, potato, acorn, sago and waxy maize, and also to the limit dextrin obtained from waxy maize starch by the action of purified β-amylase. In every case glucose was just detectable, but in such small amount (less than 1 per cent by weight of the starch used) that its quantitative significance is uncertain. On the other hand, the point of special interest which emerges is that it now becomes clear that, in all these amylopectins, by far the greater proportion of the side-chain linkages (more than 75 per cent) are of the 1 : 6 variety, and at most only a small proportion of them can involve either C_2 or C_3, a result which is of particular interest in connexion with theories of the enzymic synthesis of amylose and amylopectin from glucose 1-phosphate. The method is obviously applicable to other problems in polysaccharide chemistry, and it has recently been utilized by Mr. A. E. Flood in this laboratory in a demonstration of the branched-chain structure of several plant gums, including xylan.

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Nov. 5.

[1] Haworth, Hirst and Isherwood, *J. Chem. Soc.*, 577 (1937).
[2] Boppel and Freudenberg, *Ber.*, 73, B, 609 (1940).
[3] Hirst and Young, *J. Chem. Soc.*, 1472 (1939).
[4] Malaprade, *Bull. Soc. Chim.*, (5), 1, 833 (1934).
[5] Partridge, *Nature*, 158, 270 (1946).
[6] Flood, Hirst and Jones, *Nature*, 160, 86 (1947).

Structure of Amylopectin

Since starch can be split into maltose, the opinion has been widespread that starch is composed of chains of the maltose type[1]. Some authors, however, suggested a branched or netted structure[2,3]; comparative measurements of molecular weight and viscosity were definitely in favour of a branched structure. Haworth[4], on the other hand, deduced from end-group assays that the molecular weight is low and therefore starch is composed of straight chains of not more than twenty to thirty glucose units. However, such a view could not be maintained. Some years ago it became quite evident[5] that most starches are made up of two polysaccharides: one unbranched, for which we proposed the old name of 'amylose', and one branched, 'amylopectin'.

While the constitution of amylose seems to be well established, the problem of amylopectin constitution is still open. Haworth[6] has proposed a structure in accordance with Fig. 1 which he calls 'laminated', whereas Meyer and Bernfeld[7] favour a structure with irregular branches like the branches of a bush (Fig. 2).

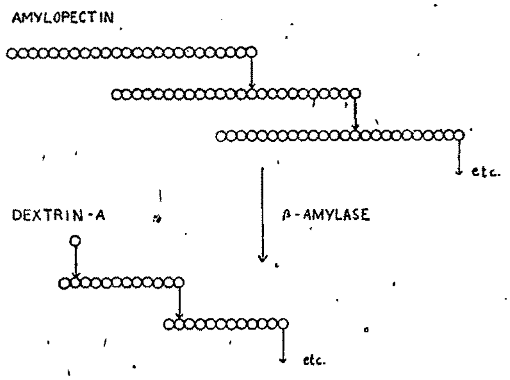

Fig. 1. Structure of amylopectin and limit dextrin according to Haworth

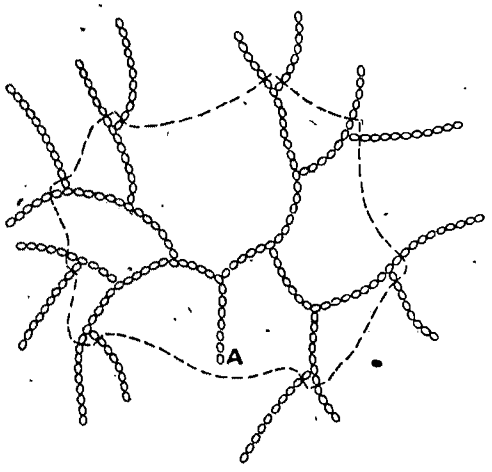

Fig. 2. Structure of amylopectin, according to Meyer. *A* is reducing end-group; limit dextrin inside the dotted line

It is possible to decide between these two formulæ when examining the properties of the limit dextrin *A* obtained by action of β-amylase on amylopectin. If the 'laminated' form were present, a very long-shaped molecule would arise, whereas the 'branched' amylopectin would yield a more compact form (indicated by the dotted line in Fig. 2). If the acetylated dextrin were composed of fibrillar molecules, its solution would easily be torn into threads, and its films obtained by evaporation would exhibit a considerable solidity such as has been found for amylose acetate and the irregularly constituted lichenin acetate[8]. If it is branched, on the other hand, it would behave like acetylglycogen or analogous products, that is, the films would be extremely brittle. In fact, we found this to be the case: the acetyl-dextrin evaporated on a glass-plate could not even be detached as film. This behaviour is definitely against the Haworth formula and is in favour of our own assumption.

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July 16.

[1] Meyer, V., and Jacobson, P., "Lehrbuch der org. Chemie", 1, 2 Teil, 1624 ff. (1913).

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[3] Staudinger, H., and Husemann, E., *Ann. Chemie*, 195, 212 (1937).

[4] Haworth, W. N., *Nature*, 129, 365 (1932). Hirst, E. L., Plant, M. M. T., and Wilkinson, M. D., *J. Chem. Soc.*, 2375 (1932).

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[6] Haworth, W. N., *Proc. Roy. Soc.*, A, 186, 1 (1946).

[7] Meyer, K. H., and Bernfeld, P., *Helv. Chim. Acta*, 23, 875 (1940).

[8] Meyer, K. H., and Gürtler, P., *Helv. Chim. Acta*, 30, 751 (1947).

Prof. Meyer's brief sketch of the history of the development of starch structures neglects some essential facts. Before starch could be formulated as consisting of repeating maltose units, proof had to be provided that maltose was preformed in starch and was not a product of synthesis by the enzymes present during starch degradation[1]. Moreover, the constitutional formula of maltose had to be determined before any such formulation of starch could be attempted[2]. The end-group method of assay showed that if starch were represented as a very large molecule, it possessed many end-groups. As early as 1936 [3], in an article on the size of polysaccharide molecules, I made these statements: "it has never been claimed by the present author that the chemical end-group method of determination of chain length corresponds with the particle size", and also "a measurement of particle size must take account of the physical molecule and the molecular aggregate. This may involve not only aggregation to increase the length of chain but also the lateral combination of the chains."

In 1934 [4], I advanced the hypothesis that large molecules containing many end-groups could be formulated by the cross-linking or mutual combination of polymeric units of limited chain-length, and I illustrated this concept in a formula for xylan. In 1937 [5], I advanced the same hypothesis in the laminated formulæ for both starch and glycogen. The nature of this polymeric bond uniting chains of limited length was postulated as an ordinary covalency link although alternatives were not excluded. The nature of this link between adjacent chains was determined later[6]. It has been the procedure of this School to advance formulations only with accompanying experimental evidence. It has been preferred to proceed stage by stage in accordance with the growth of evidence, rather than to present highly speculative formulations with little experimental background.

Evidence that amylose should be represented as continuous chains of ninety or more glucose units, largely unbranched, was published in 1942 [7] after examination of a specimen of the synthetic amylose of C. S. Hanes. This extended and confirmed the view of K. H. Meyer, who had separated amylose by Baldwin's method[8] and had shown that it was completely broken down to maltose by β-amylase, and that it did not give dextrin-*A* as a by-product as does amylopectin[9]. The laminated formula for amylopectin was advanced as a first approximation only, and is not to be regarded as the final or complete structure of amylopectin. It still serves to explain most of the known experimental facts. The multibranched structure advanced by K. H. Meyer is a development of the same concept; but at the present stage of our knowledge it seems to be premature and needlessly complex.

The point made by him above that acetylated dextrin-*A* should, on the basis of our formulation, yield films resembling amylose acetate rests on very slender evidence; and much more adequate experimental investigation will be necessary to support his contention.

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[1] Haworth, W. N., and Percival, E. G. V., *J. Chem. Soc.*, 1342 (1931).

[2] Haworth, W. N., and Peat, S., *J. Chem. Soc.*, 3094 (1926).

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[4] Haworth, W. N., Hirst, E. L., and Oliver, E., *J. Chem. Soc.*, 1917 (1934).

[5] Haworth, W. N., Hirst, E. L., and Isherwood, F. A., *J. Chem. Soc.*, 577 (1937).

[6] Barker, C. C., Hirst, E. L., and Young, G. T., *Nature*, 147, 296 (1941), and others.

[7] Haworth, W. N., Heath, R. L., and Peat, S., *J. Chem. Soc.*, 55 (1942).

[8] Baldwin, M. E., *J. Amer. Chem. Soc.*, 52, 2907 (1930).

[9] Meyer, K. H., and Bernfeld, P., *Helv. Chim. Acta*, 23, 875 (1940).

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*neo*Pentyl Alcohol and Steric Hindrance

In a note under this title, Gerrard and Nechvatal[1] have reported the conversion of *neo*pentyl alcohol, $(CH_3)_3C.CH_2.OH$ (here written ROH), by thionyl and phosphorus halides into the esters RO.SOCl and RO.PCl_2, *inter alia*. They remark that Whitmore and Rothrock[2] demonstrated the resistance of *neo*pentyl alcohol to the replacement of its hydroxyl group by halogen, through the agency of thionyl chloride and phosphorus tribromide. They add that we[3] have attributed this to the steric hindrance of what they call "end-on approach" to the α-carbon atom. They state that Whitmore and Rothrock leave the impression that *neo*pentyl alcohol does not react at all with the halides specified; but that the work of Gerrard enabled Gerrard and Nechvatal to predict the probability of an easy "broadside approach" of the reagents. We should like to add some points to this statement of the relation between the different investigations.

Whitmore and Rothrock first showed that *neo*pentyl alcohol exhibits considerable resistance to the substitution of its hydroxyl group *as a whole*, for example, by halogens; though they reported some displacement of the hydroxyl group by means of hydrogen bromide and phosphorus tribromide. They also, however, observed a fairly facile substitution *of the hydrogen atom* of the hydroxyl group in the formation of an acid ester with sulphuric acid[2]. The difference of behaviour in the two types of replacements has been fully confirmed. We developed more quantitatively the subject of replacements at the α-carbon atom and interpreted the relative difficulty of such reactions in terms of steric hindrance[3]. For example, adopting the conclusion of Cowdray, Hughes, Ingold, Masterman and Scott[4], that the first stage in the formation of halides from alcohols by reagents such as hydrogen bromide, thionyl chloride and phosphorus trichloride is the production of intermediates such as ROH$_2$Br, ROSOCl or ROPCl$_2$, we adduced evidence[3] that all the routes by which such complexes could normally yield alkyl halides are very much restricted in the *neo*pentyl system. Consequently, such intermediates should be easier to isolate in this system than in others. It is therefore very satisfactory that, while Whitmore and Rothrock had already isolated ROH$_2$Br in this system, Gerrard and Nechvatal have now isolated the esters RO.SOCl and RO.PCl$_2$.

The points we wish to make are, therefore: (1) that the reactions which Gerrard and Nechvatal have realized belong to the class (substitution of hydroxylic hydrogen) of those which Whitmore and Rothrock, among others, found to be easy, not the class (substitution of hydroxyl) which they showed to be difficult; (2) that our interpretation[3] of Whitmore's work involved the conclusion which Gerrard and Nechvatal's results support; and (3) that we did not conclude from Whitmore and Rothrock's paper that *neo*pentyl alcohol does not react at all with the reagents specified above. Gerrard and Nechvatal quote as follows from Whitmore and Rothrock's paper: "The inactivity of *neo*pentyl alcohol to heat and reagents has been demonstrated". However, this sentence is taken from the very brief final summary, and was clearly intended as a general and relative statement, not as contradicting part of the text of the paper.

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Sept. 8.

[1] *Nature*, **159**, 812 (1947).

[2] *J. Amer. Chem. Soc.*, **54**, 3431 (1932).

[3] *J. Chem. Soc.*, 173 (1946).

[4] *J. Chem. Soc.*, 1252 (1937).

Structure of Cyclopropane

DR. WALSH has defended his suggested structure[1] for the compounds ethylene oxide and cyclopropane in terms of a molecular orbitals picture based on the assumption that the carbon atoms are in the trigonal, or near-trigonal, state. The calculations by Linnett[2] of the CH-bond force-constants are consistent with trigonal bonding.

One would expect to find that the H—C—H angles in cyclopropane and ethylene oxide should lie close to 120° if the carbon atoms are indeed trigonally bonded. It is relevant, therefore, to direct attention to the results of a recent electron-diffraction study on cyclopropane, reported by Bastiansen and Hassel[3]. The photographs were obtained using a rotating-sector camera, and the results are probably more accurate than those obtained by Pauling and Brockway[4] some years ago. Bastiansen and Hassel find the following values for the distance and angle parameters:

$$\text{C—H} = 1{\cdot}08\text{ A.}; \qquad \text{C—C} = 1{\cdot}54\text{ A.};$$
$$\angle\,\text{H—C—H} = 118{\cdot}2^\circ; \quad \angle\,\text{H—C—C} = 116{\cdot}4^\circ.$$

The uncertainty in the angles is quoted at ± 2°.

Spectroscopic studies by Smith[5] have provided the value for one of the moments of inertia in cyclopropane ($I_B = 41{\cdot}91 \times 10^{-40}$ gm./cm.^{2}). The calculated moments of inertia of the Bastiansen–Hassel model are $I_A = 68{\cdot}14 \times 10^{-40}$, $I_B = I_C = 42{\cdot}68 \times 10^{-40}$. If the C—C distance in the proposed model is reduced from 1·54 A. to 1·52 A., this alteration in itself is sufficient to give complete agreement with the experimental I_B. Bastiansen and Hassel do not quote the limits of error in the C—C distance determination, which, however, can scarcely be less than ± 0·02 A. Some justification for assuming that C—C may be slightly less than 1·54 A. follows from Pauling and Brockway's estimation of C—C = 1·53 ± 0·03 A., and from O'Gorman and Schomaker's[6] estimation of C—C = 1·52 ± 0·02 A. in monochlorocyclopropane.

Although the structural data are not yet complete, the 'most probable' cyclopropane structure would seem to agree with the assumption of near-trigonal bonding, at least in respect of the CH bond-length, force-constant and HCH angle. On the other hand, the C—C distance (~ 1·54 A.) corresponds with that of C—C found in the paraffin hydrocarbons, suggesting relatively little double-bond character in the C—C bonds. From the point of view of bond-length, it is satisfactory to represent the carbon–carbon bonding in cyclopropane by single C—C bonds: this representation, however, is not satisfactory in respect of the C—C bond-energy. The thermal data on cyclopropane indicate a marked *weakening* of the C—C bonds relative to C—C in diamond or ethane[7]. In regard to this latter point, it is perhaps significant that the assumption of trigonal bonding in cyclopropane nevertheless leaves a system in which the formation of σ or π C—C bonds occurs under conditions of angular strain.

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Sept. 20.

[1] Walsh, A. D., *Nature*, **159**, 165 and 712 (1947).

[2] Linnett, J. W., *Nature*, **160**, 162 (1947).

[3] Bastiansen and Hassel, *Tids. Kjemi Bergvesen Met.*, **6**, 71 (1946).

[4] Pauling and Brockway, *J. Amer. Chem. Soc.*, **59**, 1223 (1937).

[5] Smith, L. G., *Phys. Rev.*, **59**, 924 (1941).

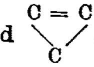
[6] O'Gorman and Schomaker, *J. Amer. Chem. Soc.*, **68**, 1138 (1946).

[7] See, for example, Skinner, H. A., *Trans. Farad. Soc.*, **41**, 645 (1945).

I AM grateful to the Editors for affording me the opportunity of writing a final letter in this discussion. The fundamental idea underlying my earlier letter[1] was that the carbon atoms in cyclopropane and ethylene oxide were in a hybridization state close to that of the carbon atoms in ethylene. The evidence was then strong. Dr. J. W. Linnett has since pointed out that the CH stretching force-constant in these molecules is much closer to the ethylene than to the paraffinic CH$_2$ value. This developed a point already made, that the height of the strong Raman frequencies indicated the same conclusion. The Bastiansen–Hassel determination of the angle HCH in C$_3$H$_6$ as 118° ± 2 provides further strong evidence for my fundamental point. (The smaller angle in the 1,1 dichloro derivative (112° ± 4 [2]) is expected since the angle ClCCl in the comparable 1,1 dichloro ethylene is reported as several degrees smaller than the angle HCH in ethylene.) Dr. H. A. Skinner's finding of accord between the Bastiansen–Hassel model and the measured moments of inertia reinforces the argument. Evidence from widely separated sources all fits together and shows that ethylene oxide and cyclopropane can be regarded as formed from CH_2 groups the carbon atoms of which are in a state of hybridization close to that of ethylenic carbon atoms. It is this most significant conclusion that a successful theory of these molecules has to explain and the implications of which have to be drawn out.

My suggested representation of the molecules was a natural one to make in order to convey an inkling of the remarkable properties enumerated above and in the second paragraph of my earlier letter[1]. Sir Robert Robinson[3] takes the usual formula to represent only the position in space of the atoms involved. This appears difficult. If we represent a bond C—C, we naturally tend to associate with it properties similar to those of the C—C bond in ethane. If we represent it C=C, we associate it and its neighbours with properties of ethenoid groups and their neighbours. Mr. L. Bateman[4] quotes Ingold as saying symbols are simply intellectual scaffolding. This seems the wiser view. My formulæ form such scaffolding. They help in suggesting the properties of linkages from the ring to other atoms or groups. It is not true that, by making the mental reservation that three resonance structures exist for cyclopropane, 'each unique feature' of the formula 'is destroyed'[3]. The olefinic properties of the CH-bonds, for example, remain. It has to be emphasized, however, that the analogy between cyclopropane and ethylene is primarily one of *valencies*. The *bonds* are only similar if similar valencies are joined to similar atoms. The CH-bonds are similar, but the two C-valencies used to bind *one* other carbon atom in ethylene are used to bind *two* other carbon atoms in cyclopropane. It is not to be expected that the CCC ring of cyclopropane should show, for example, olefinic frequencies. Controversy over the formulæ has tended to arise according as emphasis has been laid on properties of the ring binding or of the bonds external to the ring.

Knowing the approximate valencies used, it follows that the picture of overlapping atomic orbitals in cyclopropane is as (VII) of my earlier letter[1]. On symmetry grounds one then expects the density pattern for the electrons to be as (VIII) of that letter. It is here that Mr. T. M. Sugden's letter[5] is valuable, for it provides a justification of this in molecular orbital theory. His treatment may be simplified by considering only interaction in the ring plane of $2p$ and (separately) sp^2 valencies. Each of these gives rise to three molecular orbitals, one single and two degenerate. But whereas for the sp^2 valencies the single orbital is bonding and the degenerate ones anti-bonding, for the $2p$ valencies the reverse holds. Sugden's diagrams show how this arises. There are thus just three bonding orbitals into which we can fit without difficulty the six CC electrons, so that some light is shed on the stability of cyclopropane. It is easily seen that the occupied molecular orbitals give a density pattern as (VIII) of my earlier letter, two electrons being in *a* and four being found in *b* or *d* or *e*.

As already stated[1], and as Sugden's Fig. 3 also shows, this pattern can be regarded as the C_2H_4 pattern generalized to an extra dimension. In molecules of this type each carbon atom must have a hybrid atomic orbital pointing towards the molecular centre of gravity and a $2p$ atomic orbital of axis at 90° to this. These essential features are retained if we replace one of the CH_2's by digonal C. The hybrid orbital pointing towards the ring centre is now sp, the two hydrogen atoms are replaced by a second $2p$ orbital of axis at 90° to the ring plane, and a second sp hybrid projects at 180° to the first. One could build a second ring with a plane at 90° to the first. The existence of spiro-pentane with two rings at 90° is thus natural. It is to C_3H_8 as allene is to C_2H_4. Further homologues (in which adjacent rings are always at 90°) are possible by changing other CH_2 groups for digonal C atoms. A special case is the group usually pictured , of stability natural on the present, but not on older, views. These matters are described in detail in my forthcoming paper.

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[1] Walsh, *Nature*, 159, 712 (1947).

[2] O'Gorman and Schomaker, *J. Amer. Chem. Soc.*, 68, 1138 (1946).

[3] Robinson, *Nature*, 160, 162 (1947).

[4] Bateman, *Nature*, 160, 56 (1947).

[5] Sugden, *Nature*, 160, 367 (1947).

Interaction of Thionyl Chloride and Hydroxy Compounds

Human and Mills[1] have generalized the procedure of Carré and Libermann[2], who prepared, by adding an equimolecular amount of pyridine, the chlorides of the few acids which until then had withstood the action of thionyl chloride. Gerrard and French[3] found it unnecessary to use an equimolecular amount of pyridine in the interaction of thionyl chloride and hydroxy compounds, and proposed to modify the Darzens' procedure[4] by adding the thionyl chloride to a hydroxy compound with a few drops of a tertiary base, and heating for four hours at 65–80° C., which gives them the corresponding chloride.

I pointed out in 1944[5] the catalytic character of the action of pyridine or its hydrochloride: a few drops of it are enough to lower the decomposition point of chlorosulphites some 50–100° C. However, the way the procedure of Gerrard and French is proposed does not demonstrate its universality: these authors chose as examples those alcohols which react with thionyl chloride in a normal way, and do yield alkyl chlorides even without pyridine. It was interesting to see whether that process will permit the preparation of alkyl chlorides with those alcohols which lead to unusual reactions with thionyl chloride. The main interest of Darzens' procedure is its universal application.

The interaction of cyclohexanol and thionyl chloride had given rise to a controversy settled only by Kyrides[6]. Hence we treated cyclohexanol according to Gerrard and French's procedure and only obtained cyclohexene, cyclohexanol and some residual cyclohexyl sulphite. The results were due to the action of hydrogen chloride on cyclohexyl sulphite, in analogy with what we observed[7] in the action of thionyl chloride on phenols; which has been tested by saturating cyclohexyl sulphite with hydrogen chloride. After four hours contact, hydrogen chloride was removed under vacuum and the residue distilled under atmospheric pressure. The whole product had passed over before 160° C., and in that distillate we found only cyclohexene and cyclohexanol.

To see whether that decomposition was not due to pyrolysis, we submitted pure cyclohexyl sulphite to distillation under atmospheric pressure. Decomposition took place, with an abundant evolution of sulphur dioxide; rectification of the distillate showed pure dicyclohexyl oxide, b.p. 270°/760 mm. and 131°/12 mm.

Hence the following modification of Darzens' procedure: 1 mole of thionyl chloride is introduced into 2 moles of hydroxy compound, with circulation of a stream of dry air, until hydrogen chloride ceases to be evolved; 1·2 more moles of thionyl chloride is then added and left for 24 hours. Only then some drops of pyridine are added, and the mixture is heated for four hours on a water-bath to remove the sulphur dioxide. Pyridine only lowers the decomposition point of the corresponding chlorosulphite. Distillation then gives an excellent yield of cyclohexyl chloride (b.p., 141° C.; n_D, 1·462; D^{18}_{4}, 0·9765).

The same procedure gave us, with yields of nearly 95 per cent, ethyl α-chloropropionate, ethyl phenylchloroacetate, ethyl diphenylchloroacetate.

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Aug. 6.

[1] Human and Mills, *Nature*, **158**, 876 (1946).

[2] Carré and Libermann, *C.R. Acad. Sci. Paris*, **199**, 1422 (1934).

[3] Gerrard and French, *Nature*, **159**, 263 (1947).

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[5] Libermann, *Ion*, **4**, 40–41, 813 (Madrid, 1944).

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Response of New-born Children to Hypertonic Solutions of Sodium Chloride and of Urea

From all that is known about the renal function of new-born infants, it is now clear that their glomerular filtration-rates are considerably lower than those of adults, and also their clearances of urea and sodium chloride[1]. These discoveries have an important bearing on clinical practice, but much more information is required about the way in which the kidney of an infant reacts to changes in the internal environment. Accordingly, some experiments have been made to study the response of the kidney in new-born infants to a considerable rise in the osmotic pressure of the body. The children used for these experiments had all been born with inoperable meningo-myelocœles. Healthy adults have been used as controls.

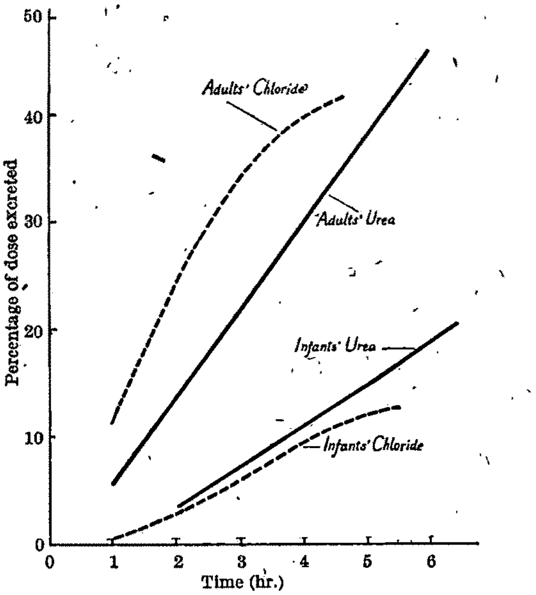
All the subjects were deprived of water for about 12 hours before the tests began. Sufficient sodium chloride was then given intravenously as a 10 per cent solution to raise the serum concentration of chlorine to about 135 m.eq./l. in the adults and to about 147 m.eq./l. in the infants. The results may be summarized as follows:

(1) A diuresis was produced in both infants and adults.

(2) On a basis of surface area, this diuresis was much smaller in infants than in adults. The greatest rate of flow in an infant has so far been 2·7 c.c./1·73 sq. m./min. All adults have exceeded a rate of 7·6 c.c./1·73 sq. m./min., and one has reached a value of 19·1 c.c./1·73 sq. m./min.

(3) The administration of sodium chloride tended to raise rather than lower the osmotic pressure of the urine in infancy, but it greatly reduced the osmotic pressure of the urine in adults[3].

(4) The infants excreted the administered sodium chloride much more slowly than adults (see graph). In one hour they excreted less than 1 per cent of the dose given, and in four hours 9·5 per cent. In the same times adults excreted 11 and 40 per cent of the dose. When comparisons were made on the basis of surface area, it was found that the maximum rate of excretion of chloride by adults was eight times that of infants. A feature of the experiments in both adults and infants has been that the diuresis produced by the salt solutions fell off while the concentration in the plasma was still high. No satisfactory explanation of this can be suggested at present.



Urea has been given by mouth as a concentrated solution to adults and infants in quantities sufficient to raise the blood urea to about 30 m.mol./l. The response at both ages has had the same general characters as the response to sodium chloride (see graph), but the differences between the adults and the infants have not been so great and the maximum output of urea by the adults per unit of surface area has not been more than six times as great as that of the infants. The diuresis, moreover, which at its peak was only about one third as great as that produced by the salt solutions, declined more slowly and the rate of excretion of the urea was better maintained.

It is evident that the kidneys of human infants respond better than those of new-born rats to the administration of strong solutions of sodium chloride and urea[3], but that the responses are essentially similar in nature. It is likely that these signs of immaturity will be demonstrable in all young mammals, but that no two species will show them to the same degree.

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Oct. 18.

[1] McCance, R. A., and Young, W. F., *J. Physiol.*, **99**, 265 (1941).

[2] Hervey, G. R., McCance, R. A., and Taylor, R. G. O., *Nature*, **157**, 338 (1946).

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Hypertension after Bilateral Nephrectomy in the Rat

Jeffers, Lindauer, Twaddle and Wolferth[1] reported in 1940 that removal of three of the four kidneys in a pair of parabiotic rats resulted in hypertension in the nephrectomized animal. Grollman and Rule[2] found in two pairs of parabiotic rats that removal of the kidneys in one animal sufficed to induce hypertension. When these experiments were repeated by one of us (E. B.-M.) a definite rise in blood pressure was found only in three out of twenty-three pairs, however.

We have modified the procedure by joining three rats in parabiosis, one bilaterally nephrectomized between two normals. In such case the survival-time of the nephrectomized rat is regularly prolonged and it remains in a good general state for a week or longer. In all the six trios prepared, definite hypertension was observed in the nephrectomized animal. A moderate rise in blood pressure was also observed a few times in one or both of the normals. The rise in pressure in the nephrectomized animal occurred two to four days after the removal of the kidneys and the highest figures noted were 156, 144, 170, 190, 172 and 144 mm. mercury.

These results led us to investigate more systematically the blood pressure of single rats after total nephrectomy. A total of 39 normal adult rats were nephrectomized and the blood pressure determined daily until death occurred. A definite rise was observed in 13 rats (33 per cent) (see table); in all these, blood urea was high. In 14 animals a solution of Ringer with 0·5 per cent gelatin was allowed to flow through the peritoneal cavity at a rate of 1 ml. an hour during 1–3 hours, the animal being anæsthetized with nembutal (30 mgm./kgm.) or ether.

BLOOD PRESSURE 1–4 DAYS AFTER NEPHRECTOMY

1	2	3	4
80	120	104	
94	144	90	
	92	130	
90	80	124	
118	80	106*	200
112	116	148	
96	100	136	
104–128	116–116	104	124
100–104	108	96*–126	108
96–100	112	148	
92	80	140*–138	
100– 90	128		
116	128		
110	92*	140	

* Peritoneal washing.

From the table it is evident (1) that the rise in blood pressure mostly occurs during the second or third day after nephrectomy; and (2) that peritoneal washing does not lower the pressure but may increase it. In some cases there were indications of an improvement in the state after washing, though the blood urea showed only a moderate fall.

The results indicate that since hypertension may occur in the absence of kidneys, some extra-renal factor is of importance for the development and maintenance of this type of state of hypertension in the rat. It is tentatively assumed that the normal kidney inactivates some extra-renal factor producing hypertension under certain conditions.

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Stockholm. Aug. 21.

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[1] Jeffers, W. A., Lindauer, M. A., Twaddle, P. H., and Wolferth, C. C., *Amer. J. Med. Sci.*, 199, 815 (1940).

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Influence of Choline and Ethanolamine on the Rate of Formation of Phospholipids in the Liver

THE work described below was carried out in the Biochemistry Department, University of Liverpool, but in consequence of war it had to be abandoned early in 1940. As the results have not been reported elsewhere, it was considered to be of interest to record them.

Using radioactive phosphorus, Chaikoff[1] made an extensive study of phospholipid metabolism, in which he showed that choline caused an increase in the rate of phospholipid turnover in the livers of rats maintained on a 40 per cent fat diet. The maximal increase of 30–40 per cent over the controls was reached six hours after the administration of choline by stomach tube. He suggested that the stimulation of phospholipid turnover was the mechanism by which the choline exerted its lipotropic action. McHenry and Patterson[2] have since supported this suggestion. It occurred to us, however, that this rise in the turnover rate might merely be a mass action effect due to the temporary increase in the concentration of choline, a constituent of the lecithin of the liver phospholipids. If this were the case, it would be expected that the increased rate of turnover would be confined to the lecithin fraction. It would also be expected that the administration, under similar conditions, of ethanolamine, which is not lipotropic[3,4], would also cause a rise in the rate of phospholipid turnover, the increase in this case being confined to the cephalin fraction. As will be seen, this was, in fact, found to occur.

As a preliminary experiment, the relative rates of lecithin and cephalin formation in fed and fasted rats were compared. Five rats on stock diet were injected with radiophosphate in saline, killed six hours later and the organs extracted with ethanol and ether after pooling and grinding with sand. The extracted lipoids were dissolved in ether and fractionated in the usual way. Five rats fasted 22 hours before death were treated similarly. The radioactivity of the samples was measured on a Geiger counter and the specific activity calculated. The specific activity is defined as the percentage of injected radiophosphate which is present per mgm. of phosphorus in the particular phosphatide preparation.

TABLE 1

	Specific activity of fed rats		Specific activity of fasted rats	
Tissue	Lecithin	Cephalin	Lecithin	Cephalin
Liver	0·42	0·29	0·31	0·21
Kidney	0·31	0·16	0·15	0·10
Small intestine	0·18	0·12	0·13	0·07

It can be seen that though the specific activity of the lecithin is greater than that of the cephalin, the relative increase from the fasted to the fed rats is approximately the same.

The influence of choline on the rates of turnover of the phosphatide fractions in the liver was determined as follows: ten rats were maintained on a 40 per cent fat, 10 per cent albumin diet, and on the seventh day each received an injection of radiophosphate in saline. Five rats received the diet as usual, while the other five had, in addition, 50 mgm.

TABLE 2

	Specific activity	
Group	Lecithin	Cephalin
Control	0·36	0·24
Choline	0·44	0·26

choline mixed with the diet. Six hours later the animals were killed, and the liver phosphatides extracted and fractionated.

It can be seen that the increase in the specific activity is confined to the lecithin fraction.

In order to compare the effect of ethanolamine feeding with choline feeding, 24 rats were given the high fat diet for six days and injected with radiophosphate on the seventh, as before, but 8 rats received 50 mgm. of choline by stomach tube and 8 rats received 50 mgm. of ethanolamine similarly. The total phosphatides were prepared from the livers and their activity measured.

This experiment was repeated, except that the ethanolamine dose was reduced to equimolar proportions to the choline, namely, 30–50 mgm., and the control group received 1 ml. of distilled water by stomach tube. The phosphatides were fractionated.

TABLE 3

Group		Specific activity		
		Total phosphatide	Lecithin	Cephalin
1.	Control	0·43		
	Choline	0·67		
	Ethanolamine	0·70		
2.	Control	0·39	0·44	0·35
	Choline	0·52	0·57	0·43
	Ethanolamine	0·69	0·57	0·77

It can be seen that the ethanolamine in both the experiments caused a rise in the specific activity, and therefore in the phospholipid turnover, similar to or greater than that produced by choline, the effect of each base being greatest in the phospholipid fraction of which it was a constituent.

As ethanolamine has no lipotropic action[3,4], it would seem unlikely that choline exerts its lipotropic activity by stimulating phospholipid turnover, unless lecithin plays a much more active part in fat metabolism than cephalin. In view of the similar rise in the specific activity of lecithin and cephalin from fasted to fed rats, this seems improbable. Chaikoff[1] found that methionine, which is lipotropic, caused a rise in the specific activity of liver phospholipids, but he also found that cystine and cysteine, which are negatively lipotropic, produced a similar rise. He suggested that this discrepancy was due to the short duration of the experiment. The same criticisms could be levelled against the results recorded here, but as the effect of choline on the rate of phospholipid turnover is itself lost after 12 hours, and the comparison of lipotropic and non-lipotropic factors was carried out under identical conditions, this seems scarcely justifiable. It would be desirable to extend this work with larger numbers of animals, but the results show that there is no correlation between the lipotropic activity of choline and ethanolamine, and their ability to stimulate phospholipid turnover in the liver.

We wish to thank Dr. J. H. Channon for his advice and encouragement, and Sir James Chadwick, from whom the radiophosphate was obtained, for his advice and assistance with the radioactivity measurements.

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* Dr. A. P. Platt died in March 1945.

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The Matter-Radiation Cycle in the Cosmos (and the Second 'Law'): the Sun's Equilibrium

IF one scrutinizes the chances of radiation, such as arises even in the observable part of the cosmos, escaping sufficiently to leave as low a temperature for interstellar matter as the 3·2° A. estimated (or even as the temperature of the earth)—on the supposition that nothing but heat (or re-radiation) is produced—one finds that it cannot possibly do so.

Knowing the fraction of a cross-section of the whole that is occupied by nebulæ (some 10^4 light years in virtual radius and 2×10^6 light years apart), and using the very low estimate of 20 per cent absorption in crossing a nebula (it is an average 60 per cent for the unusually large galaxy, at the sun's very eccentric location), it is found that the fraction of radiation penetrating to 5×10^8 light years, the limit of present well-defined observation, is about 0·997, and certainly cannot be as near unity as, say, 0·99999. But 0·997 corresponds to an interstellar temperature of $6{,}000 \times \sqrt[4]{1 - 0{\cdot}997}$, or about 1400° A., and even 0·99999 to 340° A. (Since photographs by the 100-inch reflector show objects that are likely to be nebulæ similarly distributed to a few times 5×10^8 light years, the case is actually stronger than this—observationally; hypothetically, it is stronger again, for one cannot easily think of space, whether infinite or in some way bounded, as unpopulated.)

Therefore, unless we wish to indulge in speculations about some entirely intangible third form of mass, we are forced to conclude that the trapped radiation is converted, mostly in the denser 'shells' of gravitationally and radiatively balanced matter between the stars, into more matter, such as returns to the stars in the manner known of as 'accretion'. Evidently a surface phenomenon, this is easily shown to occur at a rate far too small to be observed in the laboratory, namely, at some 4×10^{12} gm. per sec. in contact with, roughly, 10^{33} gm. After all, why should not a change that occurs at extremely high temperatures be capable of reversal at lower temperatures (one can add, speculatively, possibly at superconduction levels)?

It should be clearer than it is that the second 'law' of thermodynamics, of no account in the microcosmos, is only an appearance in the 'mesocosmos' (where we reside), which is counteracted in the macrocosmos of gravitational 'supremacy', a matter first evident in Jeans' 'gravitational instability'. Dean Inge had no need to write as virtually despairingly as he did in "God and the Astronomers".

A conclusion to be drawn from this is that an average star, such as the sun is providentially ('teleologically' is very like a synonym), tends to keep constant mass, although in the fashion, *cet. par.* (that is, apart from more 'teleology'), of unstable equilibrium; for accretion is proportional to $(\text{velocity})^{-3}$ and velocity is proportional to $(\text{mass})^{-1/2}$.

The subject will be discussed at more length in another place.

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Crystal Structure of Cyanoethyl Cellulose

In the X-ray study of cyanoethyl cellulose filaments[1], made from products of varying cyanoethyl content, it has been found possible to identify at least two forms of crystalline structure. Fig. 1 is an X-ray diagram of filaments made from alkali-soluble material, containing in this case 2·0 per cent nitrogen, corresponding to a substitution of less than one group per glucose residue in the cellulose. The X-ray diagram can be seen to be somewhat similar to that of hydrate cellulose; the normal repeat of pattern of 10·3 A. (approximately) of the cellobiose residue is retained along the fibre axis. It is most probable that the substitution of the cellulose occurs throughout the whole structure, and in these circumstances the obvious falling off in definition of the X-ray diagram is due to distortion of the crystalline lattice, caused by the replacement of certain of the (OH) groups by (OC_2H_4CN) groups. Fig. 2 is an X-ray diagram of acetone-soluble cyanoethyl cellulose filaments containing on an average 2·73 groups per glucose residue; complete cyanoethylation can be represented by the formula: $(C_6H_7O_2.(O.C_2H_4CN)_3)_n$. A preliminary study of this fibre diagram has shown that the crystal structure is built up in the following way.

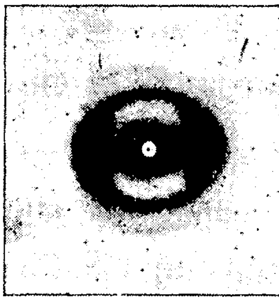

Fig. 1

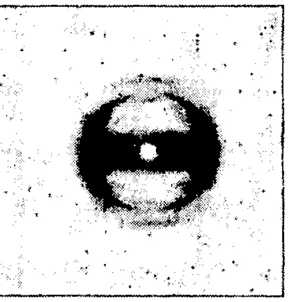

Fig. 2

Fig. 1. X-RAY PHOTOGRAPH OF FIBRES OF ALKALI-SOLUBLE CYANOETHYL CELLULOSE WITH A NITROGEN CONTENT OF 2 PER CENT. COPPER $K\alpha$ RADIATION. $D \approx 2{\cdot}1$ CM. (ON REPRODUCTION).

Fig. 2. X-RAY PHOTOGRAPH OF FIBRES OF CYANOETHYL CELLULOSE WITH AN AVERAGE SUBSTITUTION OF 2·73 CYANOETHYL GROUPS PER GLUCOSE RESIDUE. COPPER $K\alpha$ RADIATION. $D \approx 2{\cdot}1$ CM. (ON REPRODUCTION).

(1) The period along the fibre axis is $15{\cdot}2_1$ A., which indicates that the repeat is made up of three glucose residues. Hence the cellobiose configuration of the normal structure is not retained.

(2) The structure of the ether presents some difficulties in interpretation, as it is not fully substituted; but the X-ray diagram can be indexed at least to a first approximation on a hexagonal lattice, with the intense reflexions on the basal layer line arising from the (100) plane, and with the (010) and (020) reflexions absent or very weak. A structure may be assigned as follows: $a = c = 9{\cdot}7_4$ A.; $b = 15{\cdot}2_1$ A. (fibre axis); $\beta = 120°$.

This would be consistent with one chain per unit cell, containing three consecutive tricyanoethyl glucose residues arranged on a three-fold spiral along the fibre axis. Further, the above structure has a theoretical density of 1·28 gm./c.c., which is in good agreement with the value of 1·27 gm./c.c. found in white spirit. It is, however, emphasized that this postulated structure is only provisional and may well be a sub-multiple of a larger cell. At present, however, this has been found to be the best possible approximation.

Infra-red studies of the material have shown that in the cyanoethers of low substitution it is possible that some amide groups may be present. It also appears that some of the ethers of equal nitrogen content are soluble in water, whereas others are only soluble in alkali; the cause of this difference is most probably to be found in a more uniform substitution throughout the cellulose structure by cyanoethyl groups in the case of the water-soluble specimens. A final interpretation of the X-ray diagram of tri-cyanoethyl cellulose must await the elucidation of the problems of the types of ether groups present, together with data from a fully cyanoethylated specimen.

We wish to thank the directors of Messrs. Courtaulds, Ltd., for permission to publish this note.

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Sept. 9.

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[1] Courtaulds, Ltd., and MacGregor, J. H., Brit. Pat. 588,751; and Brit. Pat. Applic. No. 34,508/1945.

X-Ray Diffraction Studies of a Nickel–Thoria–Kieselguhr Catalyst for Fischer–Tropsch Synthesis

A nickel–thoria–kieselguhr (100 : 18 : 100) catalyst prepared mainly according to Fischer and Meyer[1], and rendered completely alkali-free after reduction, by washing with water, was studied by the Debye–Shearer method.

A Debye – Shearer photograph of the kieselguhr used was taken before treatment. This photograph showed a number of sharp diffraction lines and a strong halo. It appears, therefore, that the kieselguhr consists of partly crystalline and partly vitreous or finely colloidal particles. The Bragg angles of reflexion and the spacings corresponding to the diffraction lines are given, along with their eye-estimated intensities, in Table 1.

TABLE 1

Bragg angles of reflexion for copper $K\alpha$ corresponding to diffraction lines	Spacings corresponding to diffraction lines	Eye-estimated intensity
10° 39′	4·20	m.s. (diffuse halo)
13 22	3·37	m.w.
14 48	3·02	m.
15 52	2·81	v.v.w.
17 55	2·54	v.w.
19 42	2·30	w.
21 30	2·11	w.
23 45	1·92	w.
24 21	1·87	w.
28 39	1·62	v.w.
30 20	1·52	v.w.

The X-ray diffraction diagram of a powdered sample of the nickel–thoria–kieselguhr catalyst shows the presence of a few diffraction lines of nickel together with some diffraction lines of the kieselguhr. The weak lines of the kieselguhr having Bragg angles 17° 55′ and 30° 20′ only appeared in this photograph. This shows that in the process of depositing nickel on the kieselguhr the structure of the latter has undergone a change. The two lines of the kieselguhr which appear in this photograph have been identified to be the strong lines of ferric oxide present in the kieselguhr. The lines of silica observed in the photograph of the kieselguhr are absent in that of the catalyst. It is therefore concluded that during deposition of metallic nickel and thoria on the kieselguhr the crystalline portion of silica (at least, a major part of it) becomes amorphous, while the structure and the crystallinity of ferric oxide present in the kieselguhr remain unchanged. The broadness of the lines, however, indicates that the crystal particles of ferric oxide have been disintegrated, yielding crystallites of smaller size.

At first it was thought that heating of kieselguhr in hydrogen during deposition of nickel and thoria was responsible for the change in its structure. To test this a powder photograph of the sample of kieselguhr previously heated at 450° C. in an atmosphere of hydrogen was taken. This photograph was exactly similar to that of kieselguhr taken before it was heated. This proves that heating alone is not responsible for the change of structure on deposition of the nickel–thoria. A photograph of kieselguhr on which only thoria was deposited according to the Fischer – Meyer method (*loc. cit.*) shows a pattern similar to that on which the nickel–thoria was deposited. The change in the kieselguhr, therefore, was brought about by the disintegration caused by the decomposition of the carbonates of nickel and thorium deposited as an initial step in the preparation of the catalyst.

The powder photograph of the sample of the nickel–thoria–kieselguhr catalyst after it has been used in catalysing higher hydrocarbon synthesis at 180° C. at atmospheric pressure is identical with the X-ray powder diagram of the same sample before use. The presence of nickel lines in the photographs proves that nickel is present in crystalline form in these samples. From the measurement of the glancing angles of reflexion of the nickel lines observed in these photographs, it appears that the lattice constant of nickel has not changed appreciably during its deposition on the kieselguhr. It may, therefore, be concluded that the atomic diameter of the nickel does not change during deposition or during the process of catalysing the Fischer – Tropsch synthesis under our experimental conditions.

The presence of two weak lines of thoria in the thoria–kieselguhr sample proves, on the other hand, the crystallinity of thoria deposited on the kieselguhr.

The X-ray data for the nickel–thoria–kieselguhr catalyst are given in Table 2.

TABLE 2

Bragg angles of reflexion for copper $K\alpha$ corresponding to diffraction lines	Spacings corresponding to diffraction lines	Eye-estimated intensity	Calculated spacings of possible reflecting planes of Ni	Spacings of ferric oxide	Eye-estimated intensity
17° 44′	2·537	m.w.		2·533	v.st.
22 18	2·029	m.	2·029 (111)		
25 53	1·759	m.w.	1·757 (200)		
30 32	1·520	v.v.w.		1·485	m.s.
38 25	1·239	v.w.	1·243 (220)		
46 40	1·059	v.w.	1·060 (311)		

Our thanks are due to Prof. K. Banerjee for the interest he took in this investigation.

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[1] *Brenn.-Chem.*, 12, 225 (1931).

The Measurable and the Non-measurable

IN the interesting address by Prof. H. Dingle, which appeared in *Nature* of July 26, 1947, there is one section about which considerable difference of opinion may exist. He quotes with disapproval the statement of Eddington ("Nature of the Physical World", p. 275), "The cleavage between the scientific and the extra-scientific domain of experience is not a cleavage between the concrete and the transcendental but between the metrical and the non-metrical", and he names the theory of evolution as completely confounding Eddington's assertion, because the theory of evolution is undeniably a scientific theory but it "has nothing whatever to do with measurement . . . it is concerned with qualitative changes alone . . . yet intelligent and learned men say and believe that science is concerned only with measurement !"

Surely it is not a quibble to deny that science is concerned only with measurement and yet to affirm that the domain of science is the measurable, that is, all the phenomena and experiences for which the fundamental units mass, length, time have relevance. The domain of ethics, æsthetics, the entire realm of values and significance is the non-measurable in the sense that the units $[M]$, $[L]$, $[T]$ are not applicable and have no relevance. The theory of evolution lies within the domain of science because it deals, though in a qualitative manner, with differences which are essentially measurable. There would be no theory of evolution if in the vegetable and animal kingdoms there were no observable differences in factors for which $[M]$, $[L]$, $[T]$ have relevance. An observer notes the difference between a ginkgo tree and an oak, between a crocodile, a horse and a man, without recourse to ruler and scales, but the differences are measurable and their existence has led to a theory which implies a time sequence. No one would suggest that if the time scale were accurately known, it would be entirely irrelevant to the theory of evolution.

The distinction between inquiries in the realm of the measurable and of the non-measurable has helped many people to place science in its right perspective relative to other approaches to knowledge and to truth. Such a generalization may be open to argument, but is it of so dangerous and vicious a nature that "the mask of comedy drops from it and it appears tragical" ?

The domain of the non-measurable is a matter of concern for everyone, and very particularly for the man of science who must step outside the domain of his own discipline to play an active part in this matter of ethics, because it is the misuse of science that confronts the present generation with a problem of first magnitude.

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I CANNOT accept Dr. Douglas's view that because one could, but does not, measure the objects with which biology is concerned, one can therefore claim that the domain of biology is metrical. On those lines one could claim music and painting and poetry as sciences. However, our views do not matter, because Eddington himself has settled the question. He claimed to derive the ultimate laws of Nature from the *nature of measurement*, not from the character of the objects to which measurement was applied, and in his article on the cosmical number, reprinted in his posthumous work "Fundamental Theory", he proceeded to deduce them from the *details* of the act of measurement—the necessity for four entities such as the two ends of the measuring scale and those of the rod to be measured, etc. He sought to meet the difficulty of biology not by forcing it into the metrical scheme but by denying that it was science and classifying it with theology.

I agree that the distinction between the metrical and the non-metrical has led many people to place science in a perspective; I do not agree that it is the right perspective, and I still think that error on such a matter is tragical, whether it is an error that conforms to our prejudices or not.

HERBERT DINGLE

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A Rapid Method of Analysis for Certain Surface-Active Agents

WE note with interest a letter by S. R. Epton[1] which describes a partition end-point method for estimation of surface-active agents in solution. We can confirm that such a method gives accurate and reliable results, since a method similar in essentials has been in use in these laboratories for the last two years and was described by one of us in a lecture to students of the Manchester College of Technology in February of this year.

A complete description of our method, which embodies an improvement over the methylene blue method, was submitted for publication to a chemical journal on September 3, 1947.

T. BARR
J. OLIVER
W. V. STUBBINGS

Dyehouse Laboratories and
Analytical Laboratories,
Imperial Chemical Industries, Ltd.,
Hexagon House,
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[1] *Nature*, 160, 795 (1947).

"Structure of Spectral Lines"

IN *Nature* of August 23, p. 244, Dr. D. A. Jackson reviews my recent book on "High-Resolution Spectroscopy" (Methuen, 1947). After considerable hesitation and with much reluctance, I feel compelled to comment on several misrepresentations made by Dr. Jackson. That he appears to dislike my method of historical approach is a matter of personal taste with which I do not quarrel, but I cannot allow incorrect assessments of my views to pass unchallenged.

With regard to light sources, his failure to appreciate the wide range and applicability of the various hollow cathode sources I have described is fairly widespread, and indeed this common attitude was a prime reason for their inclusion. By far the biggest volume of published work in hyperfine structure has been made with the different varieties of hollow cathode source.

With regard to the atomic beam as a source, Dr. Jackson quotes me as saying (p. 82), "it is therefore very easy to miss weak components". My complete statement reads, "it is therefore very easy to miss weak components in a structure *if the beam is not dense enough*" (italics added). I think, too, in the circumstances, that the six lines of the review referring to the detection of weak components in potassium (made by Drs. Jackson and Kuhn) could well have been spared, since I give these very details on the following page, with due apportioning of credit.

What astonishes me is the accusation that I understate the superiority of the Fabry–Perot etalon, and I can only conclude that Dr. Jackson has not read my sentence on p. 89: "The Fabry–Perot interferometer has therefore greater power than any of the other instruments in general use". Needless to say, my treatment makes this so obvious that I am quite dumbfounded at Dr. Jackson's failure to appreciate my outlook. I devote 143 pages to instruments: 25 pages to the echelon, 38 pages to the Lummer plate and 80 pages to the Fabry–Perot etalon. If Dr. Jackson does not realize that fact, surely he saw the clear table on p. 88, where I place the Fabry–Perot at the head of the instruments listed in order of practical importance. I feel strongly that misrepresentation in this matter is highly undesirable in the interests of spectroscopy.

Dr. Jackson makes a good deal of play with the reflectivity measurements I have quoted (be it noted, from other workers). I heartily concur when he writes that but few and contradictory measurements are available, but he cannot have it both ways, for he then proceeds to remark: "If the curve had been drawn correctly . . ." May I ask on whose authority, and to which 'correct' curve does he refer? Is it perhaps to some unpublished figures of his own, since he is able to quote figures? Dr. Jackson prefers to select his mirrors with a photo-electric meter (which, incidentally, only measures the absorption, and not the reflectivity, an issue he side-steps), but I still prefer to use 'considered judgment' in my own experiments.

Again, with regard to reflectivity, Dr. Jackson states that sputtering is obsolete; but I have taken pains to show that some quite exceptionally good figures have been reported for sputtering methods, and this should be re-examined. However, I state explicitly on p. 113: "The superiority of the evaporated film over the sputtered film is evident". I personally also only use evaporation.

Finally, Dr. Jackson dislikes mountings of the reflexion echelon other than that he himself uses, and he argues that my discussion of the limitations of his mounting is irrelevant. Surely one might be a little less partisan, and in any case a text-book writer must be.

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THE criticism which I made about Prof. Tolansky's description of the hollow cathode was that it is "concerned too much with complicated and obsolete forms". I do not fail to appreciate the work which has been done with this light-source in its most important forms, but I criticize the relative amount of space devoted by Prof. Tolansky to obsolete and little-used varieties.

With regard to the atomic beam in absorption, although it is established that this method permits the observation of lines too weak to be detected in emission, Prof. Tolansky does not mention this advantage, but deals at some length with the ease with which weak components are missed if the density of the beam is low. Obviously, weak components are not observed if the density of the beam is sufficiently low; but it is misleading to write that they are "missed", since if weak components were to be investigated a beam of low density would not be used.

Prof. Tolansky gives a curve for the reflecting power of silver layers, from which he derives values of the reflecting power of the silvered surfaces of an etalon which imply a resolving power too low by a factor of more than two; for this reason I wrote that the "general superiority and greater scope of the [Fabry–Perot] etalon is rather understated". The space devoted by Prof. Tolansky to the Lummer plate is approximately half of the total space given to the etalon and compound etalon. This attaches too much relative importance to the Lummer plate; the results obtained with this instrument compared with those obtained with the etalon are in a very much smaller proportion. The possibilities of the double etalon are understated by Prof. Tolansky. The value of this instrument depends to a great extent on the ratio of the interferometer gaps which can be used, and he states that a ratio of 4 : 1 cannot be exceeded (quoting Meissner, 1941). A ratio of 10 : 1 was used successfully in the examination of the resonance lines of lithium, in which intensity ratios of more than 10 : 1 are involved (Jackson and Kuhn, 1939); but Prof. Tolansky seems to have overlooked this.

With regard to the reflecting power of silvered surfaces, the contradictory measurements available to Prof. Tolansky were those of Strong, which give a reflecting power with red light of about 88 per cent when extrapolated for thick films, and those of Edwards and Petersen (*Phys. Rev.*, 50, 871; 1936), which gave a value of 98 per cent under similar conditions. Prof. Tolansky has drawn curves (Figs. 7.8 and 7.12) and derived all his conclusions with regard to resolving power of the etalon from the lower of these figures; if he had also considered the higher figure he would have obtained alternative much higher values for the resolving power, and would have seen that Meissner's estimate of the maximum ratio of the gaps in the double etalon, calculated on the basis of a reflecting power of 80 per cent, would be inappropriate. Direct measurements of resolving power have been made at Oxford (and are to be published); the resolving power found for red light with a film with a transmission of 4 per cent requires a reflecting power of 93 per cent, which implies a value of at least 97 per cent for a thick silver layer, in good agreement with the figure given by Edwards and Petersen.

The photo-electric meter measures the transmission of the silver layer for light of any required colour; the resolving powers corresponding to various values of transmission, extending over a large range, have been determined experimentally. The reflecting power can be calculated from the resolving power. Measurement of reflectivity is not therefore an issue which is side-stepped. Furthermore, when the photo-electric method is used, mirrors are not 'selected' after preparation; the density of the silver layer is controlled during the evaporation, and a layer with the requisite degree of transmission is obtained.

Prof. Tolansky appears to agree with my statement that evaporation has replaced sputtering (he "personally also uses only evaporation"); why then does he object to my criticizing him for devoting an approximately equal amount of space in his book to the two methods?

With regard to the mounting of the echelon grating, the aberration which Dr. Tolansky discusses cannot cause a loss of resolving power greater than 10 per cent except with objectives of shorter focal length than is permitted by the grain of the photographic plate; it was for this reason that I described a long discussion of this aberration as irrelevant. I might also have observed that another objection which Prof. Tolansky proposes (that the echelon might be curved and thus have focal properties) is not substantiated by experiment.

D. A. JACKSON

Control of Atomic Energy

THE article on the "Control of Atomic Energy" in *Nature* of November 15, p. 655, contains an important misstatement of fact that should not be allowed to pass without correction. It is stated: "The rejection by the Soviet Union of the very principles on which these proposals are based, including as they do the prohibition of atomic weapons, makes it difficult to see what further proposals can be advanced with any real hope of unanimous agreement".

This statement could only be taken to suggest that the Soviet Union has taken a stand against the prohibition of atomic weapons. In actual fact, the position is entirely different. Whatever may be the merits or demerits of the other parts of the Soviet plans on atomic energy control, the first point has always been the early conclusion of a convention to outlaw atomic weapons.

The first article of the proposed Convention, put forward by Mr. Gromyko as early as June 19, 1946, states: "The high contracting parties solemnly declare that they will forbid the production and use of a weapon based upon the use of atomic energy, and with this end in view, take upon themselves the following obligations: (*a*) not to use, in any circumstances, an atomic weapon; (*b*) to forbid the production and keeping of a weapon based upon the use of atomic energy; (*c*) to destroy within a period of three months from the entry into force of this agreement all stocks of atomic energy weapons whether in a finished or semi-finished condition".

The American and British Governments have so far not been willing to agree to such a convention until agreement on the wider aspects of control have been achieved.

E. H. S. BURHOP
(Hon. Secretary,
Atomic Sciences Committee).

Association of Scientific Workers,
15 Half Moon Street,
London, W.1.

WE regret to find that the article referred to contains an ambiguous statement. What we had in mind was that, according to information generally available, proposals for the control of atomic energy which included the prohibition of atomic weapons had been rejected as a whole by the representative of the U.S.S.R. We had no intention of suggesting that the Soviet Union was opposed to the prohibition of atomic weapons, and we do not think the phrase used need necessarily bear that construction.—EDITORS.

ORGANISATION OF THE CELL WALLS OF TRACHEIDS AND WOOD FIBRES

By A. B. WARDROP* and DR. R. D. PRESTON
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DURING the past thirteen years the finer detail of structure in conifer tracheids has been the subject of some controversy[1,2,3,4]. This has centred round the fact that when transverse sections of conifer wood are examined between crossed Nicols three layers can be distinguished in the secondary wall of a tracheid, an outer and an inner layer which are bright, and a central layer, much thicker in late wood than the other two, which is dark. A similar behaviour is observed in cross-sections of wood fibres and is shown in the case of two isolated fibres of *Nothofagus cunninghami* in Fig. 1. On the basis of observations such as the run of striations in surface view, the orientation of crystals grown in the wall and the features associated with fungal attack, Bailey and his collaborators have claimed that the optical heterogeneity is due to different orientation of the cellulose 'micelles' in the three layers; in that while the micelles in the dark layer are orientated in a steep spiral, those in the outer and inner layers lie more or less transversely[1] or, in later papers, at angles between 45° and 90° to the length of the cell[3,5]. The case where the micelles in the outer layer are orientated transversely and those in the middle layer longitudinally is shown diagrammatically in Fig. 2 (*a*). On the other hand, Preston[2,4,6,7], criticizing the validity of the use of evidence obtained from swollen or otherwise distorted walls and basing his conclusions only on X-ray and optical examination of undistorted material, has maintained that the optical heterogeneity is to be explained largely by a pronounced difference in angular dispersion between the layers (Fig. 2*b*); and that, further, any wall layers with transverse orientation can only be present to an extent so small as to give no record on the X-ray diagrams of conifer wood[7] and to cause no disturbance in the optical properties of walls in surface view[7]. The apparently contradictory X-ray evidence brought forward by Bailey and Berkeley[3] was completely disposed of as an error in interpretation[6], and it seemed at that time that the case was at last clear so far as the physical evidence went.

There still remained, however, some unsatisfactory features. It had been shown by Wardrop[8] that if single walls of tracheids or wood fibres (which were shown by Bailey[1] to manifest similar optical heterogeneity) from abnormal wood with thick cell walls, for example, compression wood in conifers, was crushed and stained with Congo Red, at least two striation directions could be detected, the dichroic properties of which showed that they did, in fact, correspond to two different micellar directions. Since only a slight change in the major extinction position was observed during crushing, no major distortion of structure could have occurred. Although such observations were made on abnormal tissue, they did suggest strongly that the structure of normal tracheids needed re-examination. Further, though little emphasis can be laid on this, it appeared that the birefringence of the outer layer in tracheids was of the same order as that in fibres and this in turn was similar to that of the associated vessels where the micellar orientation is known to be almost transverse[8]. This observation clearly pointed to the danger involved in attempting to determine micellar inclination from the birefringence of a wall in transverse section in terms of the known characteristic birefringence of cellulose. It therefore became very desirable that a sufficiently critical experiment should be designed, to distinguish clearly and irrevocably between the two hypotheses, and it is with the results of what we regard as such an experiment that this communication is concerned.

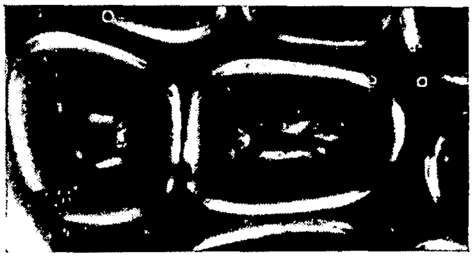
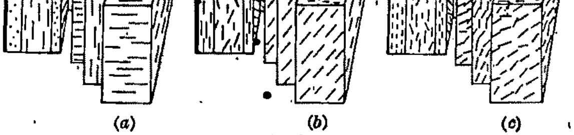


Fig. 1

Since only one of the hypotheses demands any major net change in orientation between the wall layers, it had long been evident that if the birefringence of a transverse section of a cell could be studied as the section was tilted about a line perpendicular to the direction of observation and to one wall surface, a clear-cut distinction between the hypotheses could be made. Difficulties associated both with technique and the nature of the material made this impossible, but it occurred to one of us (A. B. W.) that the same observations could be made in another way. If a series of sections is cut from a piece of wood at increasing angles to the grain, then a series of observations can be made analogous to those which could have been made on a single, tilting cell. As the tilt of the section increases, the birefringence in one wall will increase, reaching a maximum where the section is parallel to the cellulose chains, and then decrease again. If, therefore, the whole wall is, in fact, uniform in micellar orientation, the birefringence of all layers should show a maximum at the same angle of sectioning; if, on the other hand, it consists of two or more coaxial spirals, then a maximum should be reached at different tilts for each wall layer. Among the disadvantages of this method as compared with the progressive tilting of a single cell it should be pointed out that, first, since different parts of different cells are being examined in different sections, an average birefringence for many cells has to be obtained; secondly, it is imperative that all the tracheids should have spirals of the same sign; and lastly, it is preferable that outer and inner layers should have


(*a*) (*b*) (*c*)
Fig. 2

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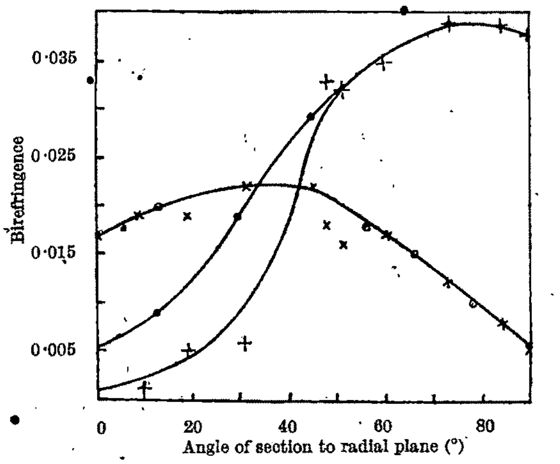

Fig. 3. *Picea*. Outer layer: ×——×, observed; ⊙——⊙, calculated. Middle layer: +——+, observed; ●——●, calculated

spirals of the same sign (even if the inclination of the spirals is indeed different). These conditions seemed to be met in a specimen of *Picea* sp. and in the fibres of *Nothofagus cunninghami*, and a series of observations was therefore made on sections from each. In both cases it was found preferable to deal with the tangential walls so that the sections were cut at increasing angles to the radial longitudinal plane. Phase difference determinations were made in sodium light with a de Sérnarmont compensator. The section thickness was later determined by turning cells on their sides and measuring directly with an eyepiece micrometer. The birefringence could then be calculated with accuracy. The orientation of the blocks of wood used to the tilting axis was kept constant so that, for example, the tangential wall nearer the pith in each cell of each section was always observed.

The results are shown graphically in Figs. 3 and 4, together with values calculated using the maximum birefringence determined experimentally. The first point to note is that the maxima do not correspond in inner and outer layers. In *Picea* the micelles in the outer layer are, on an average, oriented at an angle about 50° to the long axis of the cells, while in the inner layer the corresponding angle is 18°, comparing favourably with the angle 20° determined from the X-ray diagram. In *Nothofagus* it is somewhat difficult to determine the precise angle in the outer layer—it must lie somewhere between 90° and about 60° to the long axis of the fibres—but it is certainly much greater than the 10° (comparing with the 10° obtained from the X-ray diagram) of the inner layer. It seems, therefore, to be established by the only type of observation which could establish such a result, namely, by observation of the physical properties of untreated and undistorted walls, that the micelles in outer layers of tracheids and fibres, while not truly transverse, do at least form a spiral slower than that of the thicker layer within.

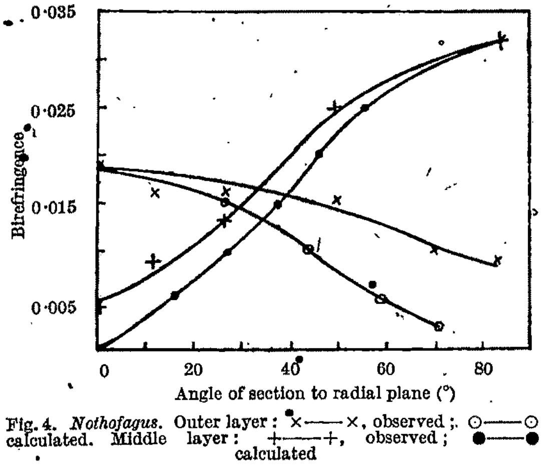

Fig. 4. *Nothofagus*. Outer layer: ×——×, observed; ⊙——⊙, calculated. Middle layer: +——+, observed; ●——●, calculated

On the other hand, however, it is equally clear that considerable angular-dispersion about this mean direction does also occur both in inner and outer layers, and that this also contributes materially to the optical heterogeneity. Thus in the inner layers, the intrinsic birefringence is obviously in the neighbourhood of 0·04, as compared with the 0·06 recorded for cellulose in ramie, cotton, etc. This lower value may be associated partly with the high lignin content of wood walls, but is certainly to be explained largely in terms of dispersion since we have observed a feature first reported by Preston[4], that the major extinction position of the wall as seen in section is often not parallel to the wall surface and is, in fact, sometimes perpendicular to it. Again, the low value of the birefringence (0·02) in the outer layer is probably due in part to the high lignification (much higher than in the middle layer, as shown by staining reactions similar to those used by Coppick and Fowler[9]) but probably reflects considerable angular dispersion. The inner layer is dark in transverse section, therefore, not only because the micellar spiral is a steep one but also because the considerable angular dispersion reduces the birefringence to a level materially lower than it would otherwise have been. Similarly, the bright outer layer is much less bright in transverse section than one would expect, again on account both of high lignification and angular dispersion. Until the determinations reported here were made it was therefore quite unsafe to attempt to make conclusions of any kind as to the interpretation of this particular kind of optical heterogeneity; and it is therefore satisfactory to find that, in fact, both the factors which had previously been stated to be causative are actually involved. The tracheids investigated here are, then, a modification of the type of organisation described by Bailey and Vestal[5], in which both inner and outer layers are spirally orientated, and is represented diagrammatically here in Fig. 2 (*c*).

One final point may perhaps be made. The low birefringence of the outer layers of the tracheids and fibres investigated here, reflecting as it probably does both a low cellulose content and a large angular dispersion, makes it seem rather unlikely to us that true striations should be visible in the outer cell wall layer. It would seem imperative that observation of striation direction should be checked against the optical and other properties of a wall before interpretation is attempted. It is satisfactory to note that the results of the investigation reported here have been used successfully by Wardrop and Dadswell[10] in an investigation of structure in tension wood fibres and compression wood tracheids.

A detailed account of the above investigations will be published later; for assistance with the sectioning we wish to express our indebtedness to the Forest Products Division of the Council for Scientific and Industrial Research, Melbourne, and to Mr. R. Metcalfe, of the Royal Botanic Gardens, Kew. We

debted to Dr. H. E. Dadswell, of the oducts Division, C.S.I.R., Melbourne, laboratory the exploratory observations , for helpful discussions of the problem.

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ORPTION OF ULTRASONIC WAVES IN LIQUIDS

ELL-ATTENDED discussion on this topic s held by the Acoustics Group of the Physical on November 13 at the Imperial College. The was opened by the chairman, Mr. H. L. who said that experimental work in this field tstripped theory, and that he hoped experi- and theoretical workers would be brought r as a result of the discussion.

. M. M. Pinkerton (Cavendish Laboratory, Cam- outlined the differences between experiment e classical theories of Stokes[1] and Kirchhoff[2], oted by Biquard[3]. The calculations had d that the absorption would be caused by ty and heat conduction respectively; in liquids at conduction term is generally negligible in rison with the viscosity term. But the experi- l behaviour of gases is now accepted as due to axation phenomenon, in the interchange of y between internal and external degrees of m. The absorption α in the majority of liquids een shown to obey the relation $\alpha/\nu^2 =$ constant, ν is the frequency of measurement. This is ound for gases when ν is much lower than the tion frequency. To pursue the work to higher ncies and obtain highly accurate data a new d had seemed desirable; from war-time ence the pulse method had appeared to be the suitable. The first results using this method been published by Pellam and Galt in 1946[4]. Pinkerton's experiments had been made by the method independently[5]. Results were presented etail for water. α/ν^2 was found to be constant the range 7–70 Mc./s., within one or two per at constant temperature. There is a fall in of about nine times between freezing and boiling ts. The observed absorption follows the expected erature variation of Stokes' theory over the e 0°–95° C., although remaining always about e times too large. This is very remarkable.

he behaviour of other liquids, as judged from lished data[4–7], can be used to divide them into itrary classes: (1) liquids where $\alpha_{obs.}/\alpha_{calc.}$ is 1,500, with a relatively small positive temperature fficient of absorption; (2) those for which $\alpha_{obs.}/$ lc. lies between 3 and 10, also with a positive erature coefficient; (3) liquids with $\alpha_{obs.}/\alpha_{calc.}$ een about 1 and 3 and a relatively large negative mperature coefficient; (4) very viscous liquids ere the Stokes relation is obeyed. Liquids of sses (1) and (2) are non-associated organic liquids, d class (3) contains the primary alcohols and ater, all typically associated liquids. Values of $\alpha_{obs.}/\alpha_{calc.}$ show a nearly regular progression from amyl alcohol to water. Mercury is not anomalous[8], the theoretical absorption being shown up to 1,000 Mc./s. The consequences of a relaxation theory, as calculated by Kneser[9], Mandelstam and Leontovitsch[10] and others, are (*a*) a dispersion of the velocity, (*b*) a maximum in the value of $\mu = \alpha\lambda$; this would correspond to α/ν^2 falling from the constant value observed at lower frequencies. Neither consequence has been verified experimentally. Various ways of estimating the relaxation frequency expected put it in the region of 10^3 Mc./s. for benzene. Hence the lack of experimental proof of a relaxation effect might be accounted for, if the measurements had been made at too low frequencies.

The variation of absorption with concentration in mixtures shows the same distinction between associated and non-associated liquids in the few cases so far investigated. In the case of two pairs of associated liquids, there is an absorption maximum at an intermediate concentration. Four pairs of non-associated liquids show an initial rapid fall, followed by an asymptotic approach to the absorption value of the less absorbing liquid. This can be explained semi-quantitatively by introducing four relaxation times for the mixture and calculating, on certain extreme simplifying assumptions, the mean overall relaxation time as a function of the molecular concentration. The variation in relaxation time has then to account for the change in absorption. In no mixture investigated has a linear variation of absorption been found.

Dr. E. G. Richardson (King's College, Newcastle-on-Tyne) said he had carried out measurements between 100 kc./s. and 1 Mc./s. He outlined the sources of error in many of the experimental techniques used in the past, stressing the undesirable effects of excessive amplitude, and of the diffraction phenomena which occur. The use of very low powers is desirable, and the pulse method fulfils this requirement well. Measurements, using a hot-wire detector, of the diffraction pattern of a source at low frequencies have confirmed the absence of scattering, mentioned by Mr. Pinkerton. Measurements of the Doppler frequency shift of light scattered by various liquids had led Raman and Rao[11] to the conclusion that the velocity of 'hypersonic' waves (identifiable with Debye heat waves) is less than that measured at low frequencies. He was uncertain if it could be shown that all the ultrasonic energy absorbed appears as heat. A method of measuring absorption at low frequencies by propagating waves in a tube might be developed. Prof. L. Tisza had suggested that the observed behaviour of liquids could be represented by the introduction of a second coefficient of viscosity[12]. This point was taken up by Dr. Temperley later in the discussion. Another theory, in which the compressibility is relaxational, has been developed for water by L. Hall[13]. Dr. Richardson was concerned that any theory to explain the absorption behaviour of liquids should not introduce too many arbitrary constants, incapable of being verified independently.

Dr. H. N. V. Temperley (Cavendish Laboratory) discussed the possibility of a coefficient of expansion viscosity. Mathematically this is easily defined, and was introduced in his calculations by Stokes. This coefficient had been shown by Maxwell to be zero for gases, but seems to have been ignored for liquids. There are several theoretical models which might be used to calculate the absorption, based on the idea of a potential cell. Such models can in all cases lead to a finite expansion viscosity. A relaxation time can be involved in the readjustment of the molecules in potential cells to a small change in external conditions. He thought that any explanation of the behaviour of water must explain the variation of both the viscosity and the absorption with temperature, since these are so closely related. The distinctions drawn between associated and non-associated liquids make it clear that different theories must be developed for the two cases.

In the discussion contributions were made by Dr. P. Vigoureux, Mr. Bayard, Mr. D. O. Sproule, Dr. J. Lamb, Mr. Ribchester and Mr. E. Bauer. Dr. Lamb referred to the theoretical papers by Dutta[14], and Dutta and Ghosh[15] on dispersion and absorption of ultrasonic waves in liquids, and measurements by Rapuano[16] up to 250 Mc./s. Venkatswaran[17] had not confirmed Raman and Rao's results for dispersion of hypersonic waves.

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FUTURE OF AGRICULTURE IN BRITAIN

IN a Friday evening discourse at the Royal Institution on October 31, Lord De La Warr discussed the prospects of British agriculture and how far it could help to meet the country's present problems of a shortage of dollars and the threat of an actual scarcity of food. The first essential, he said, is to decide the true nature of the trouble, whether it is a 'crisis' of temporary duration only or whether we are not rather being confronted with a fundamental change in our national economy. If the difficulties are merely short-term, it would seem that British agriculture has little contribution to make, since production has declined over the last two years both as regards acreage of tillage and livestock figures, and time will be needed to reverse this trend. Though increase of livestock may be the best way of farming to save dollars, the opportunity, which offered itself twelve months ago, of buying adequate feeding stuffs to do this had not been taken, so that the prospect of building up an animal population rapidly is not hopeful. During the last two years the whole world food situation has gone from bad to worse, and though this may be no one's fault, it must be admitted that interest in agricultural matters has been sadly lacking in the British nation as a whole. The word 'crisis' is, in fact, quite misleading, and its use has prevented us from realizing that the start we gained in the industrial revolution has r that cheap food and raw materials, wit sequent high standard of living to whi become accustomed, can no longer be granted. The idea that when the present ' we shall again be able to import all th require at a low price must be abandoned can hope to rebuild our shattered economy

During the last five years before the V Britain was importing on an average £50 annum more than it was exporting; that already begun to live beyond our means, then we have raised our standard of living. such as Canada, Australia and South An in the past were mainly food producers steadily industrializing themselves, therel their demands for British exports. Great in consequence, not likely to be in a fin economic position to pay for importing a proportion of food as formerly, and may e difficulty in exporting sufficient to pay for raw material to maintain her factories. It is able, moreover, whether the food is even a assuming we had the money to pay for it. the changes brought about by the industr of the great food-producing countries, there due to alterations in farming methods. The over from cereal growing to livestock pr that has occurred in the 'dust bowl' area United States and Canada means less grain a for human requirements. Furthermore, en increases in population are taking place in Inc Africa, as well as a rise in the consumption pe in these countries, due to the efforts to impr standards of health and nutrition among the peoples.

Other factors may prove of importance in ining future trends. The control of the tse and locust, for example, would open up new for agricultural development, which in the might temporarily offset this increased den food. On the other hand, the eliminatior mosquito would result in an even more rapi population in many areas.

For the purpose of feeding the people Britain, the products of British agricult therefore, literally of vital importance. The of £100 millions of food by 1952 demanded Government is moderate from the point of v the potentialities of the soil and the needs situation. In terms of the facilities now avail labour, houses, machinery, fertilizers and stuffs, however, the target is not likely to be r unless the drive behind it is intensified. It country, not the farming industry, that will su the necessary increased production is not atta and the facts and figures available point strong possibility of real hunger being expe during the next twelve months. However, the Britain is capable of producing more. Fou ago, 1½ million acres more were under cult than to-day, and there were more pigs and and about the same number of cattle.

More knowledge and better application of knowledge are needed. Means must be fou carrying over new information particularly to small farmer, and an improvement in the nat standard of education is probably the best sol to this problem. Compared with other countries farming efficiency in Britain is high; more is duced per head than in any other country in Eu

row 2½ times as much wheat per acre as in
d States or Canada. We are highly mech-
d in many cases our costs compare well
we have to import. Both soil and climate
favour and our workers are good. The
r trouble is the national unwillingness to
this is no 'crisis' with which we are faced,
term, if not permanent, change. Not until
pletely accepted will the requisite national
out behind our agricultural drive. Labour,
chinery, fertilizers and feeding stuffs are
iate needs. But they are only the begin-
atever our shortages and difficulties may
ntryside must be re-equipped with new
ouses, electricity, water and transport.
best that science can give, and we are
drawing into agricultural research some of
brains that science can produce. But we
e; in fact, if the land of Great Britain is
f its best, it will demand a greater share of
tion of our national wealth, its energies,
income, raw material and, above all, its

o, it will take time to achieve the necessary
production, and when we have achieved it,
not have solved the whole problem of
the 45 million people who inhabit Great
Neither agriculture nor any other single
can provide a panacea. In fact, one of the
lessons that this generation will have to learn
the coming hard times is to give up this passive
belief that panaceas exist. But granted the
ess of the nation to change, and change
entally, its whole attitude to agriculture,
no other industry in the country that can
great a contribution—long-term contribution
future of Great Britain.

HOLOGY OF GLASSHOUSE CROPS

thirty-first annual report for 1945 of the
hunt Experimental and Research Station
s Hill, Cheshunt, Herts, 1946) sets forth the re-
several pieces of research into the pathology
house crops.

Mr. Williams has investigated the effect of tem-
re and humidity on the pathogenicity of
llium albo-atrum* and *V. dahliæ*. He finds that
lo-atrum* made very little progress when in-
ed to tomato plants growing in a closed
ber, with temperature and humidity higher than
al. The plants did not wilt in this environment.
dahliæ, on the other hand, caused about the
amount of disease in a closed chamber and
normal conditions. *Verticillium* wilts do not
to owe greater severity of attack to increasing
moisture. Cucumber plants wilted under con-
which checked the disease due to *V. albo-*
in tomatoes.

fungus *Didymella lycopersici* causes a severe
ot of tomato plants. Mrs. Enid Sheard has
that the disease can spread by air-borne
es, that an attack is more severe where plants
grown in soil which has been steam-sterilized
re inoculation than in unsterilized soil, and that
fungal strain which attacks only the fruit of out-
tomatoes will not cause stem rot under glass.
h O. B. Orchard, Mrs. Sheard has found that aerial infection is controlled by fumigation with formaldehyde vapour. W. H. Read has also attempted control of the disease by applying various fungicides to the surface soil of glasshouses, before and during planting.

I. W. Selman has found that fruiting tomato plants may show marked resistance to invasion by mosaic virus, and that inorganic nutrition also has an effect in promoting resistance to mosaic. Experiments are in hand to determine the nutrient balance most favourable to resistance. An interesting application for disease control by antibiotics is investigated by Erma Grossbard. A strain of *Aspergillus clavatus* has been used to depress the incidence of 'damping-off' of tomato seedlings by the fungus *Phytophthora cryptogea*. Antibiotic properties were also demonstrated against *Bacillus carotovorus*. Further trials with petroleum emulsion for the control of red spider mite have been made by E. R. Speyer and W. J. Parr. Large-scale use of D.D.T. has proved of value against the tomato moth, but applications of sodium ethyl xanthate against root-knot eelworm have not provided much hope of commercial control.

Several non-pathological investigations have also been made. They include the Station's continued work on general cultivation, an evaluation of the use of sulphur and sulphuric acid for making alkaline soils more acid, the choice of extractants in soil analysis, and the effect of plant hormones on the setting of tomato fruit.

FORTHCOMING EVENTS

Wednesday, December 31

Royal Microscopical Society, Section of Industrial Microscopy (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mr. F. D. Armitage: "Microscopy of Paper".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Engineer in the Audio Frequency Section of the Research Department, based in London, Engineers (2) in the Field Strength Section of the Research Department, based at Oxford, Engineers (senior and junior) in the Designs Department in London—The Engineering Establishment Officer, B.B.C., Broadcasting House, London, W.1 (January 3).

Assistant Chemists (2) in the Chemistry Branch of the Department of Agriculture and Lands, Southern Rhodesia—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (January 5).

Superintendent in the Ship Division of the National Physical Laboratory in the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2065 (January 7).

Rankin Lecturer (Grade I) in the Prehistoric Archæology of Western Europe, and a Charles W. Jones Lecturer (Grade II) in the Department of Ancient History and Classical Archæology—The Registrar, The University, Liverpool (January 8).

Lecturer in Electronics in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (January 12).

Principal Scientific Officer at the Royal Air Force Institute of Aviation Medicine, Farnborough, Hants, under the Air Ministry—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2071 (January 12).

Chief Conservation Officer in charge of the Conservation Branch of the Irrigation Department, Southern Rhodesia—Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (January 21).

Director of Museums—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2, endorsed 'Director of Museums' (January 26).

Chemist for an investigation of the isolation and analysis of the insecticidal constituents of pyrethrum flowers—Dr. S. H. Harper, Chemistry Department, King's College, Strand, London, W.C.2 (January 31).

Head of the Department of Physics (Senior Lecturer)—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (January 31).

Director—The Director, National Museum of Wales, Cardiff (February 28).

Lecturer in the Department of Electrical Engineering and Physics—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

TECHNICIAN in the City Hospital Laboratory, Urquhart Road, Aberdeen—Dr. Smith, The Laboratory, City Hospital, Aberdeen.

DIRECTOR OF RESEARCH—The British Hydromechanics Research Association, 94–98 Petty France, London, S.W.1.

LABORATORY TECHNICIAN (male)—The Secretary, Department of Parasitology, School of Tropical Medicine, Pembroke Place, Liverpool 3.

HEAD OF THE SCIENTIFIC DIVISION—The Director of Research, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering, Northants.

REPORTS and other PUBLICATIONS

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Gas Research Board. 8th Annual Report of the Council of the Gas Research Board, 1946. (Communication GRB. 30). Pp. 62. (London: Gas Research Board, 1947.) [85

London School of Hygiene and Tropical Medicine. Report of a Meeting of the Ross Institute Industrial Advisory Committee. Pp. 36. (London: London School of Hygiene and Tropical Medicine, 1947.) [85

Anti-Locust Memoir 2: Migrations and Breeding of the Red Locust (*Nomadacris septemfasciata* Serville) in Africa, 1927–1945. By V. Morant. Pp. 60. (London: Anti-Locust Research Centre, British Museum (Natural History), 1947.) 6*s*. [85

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Forestry Commission. Booklet No. 1: Woodland Mosses. By H. Watson. Pp. 48. 2*s*. net. Forest Operations Series, No. 2: The Establishment of Hardwoods by Sowing or Planting. Pp. 36. 9*d*. net. Leaflet No. 19: Elm Disease, *Ceratostomella ulmi*. Revised edition. Pp. 8. 2*d*. net. (London: H.M. Stationery Office, 1947.) [85

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